Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

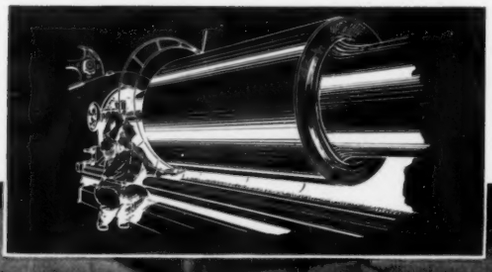
ATTEND THE IRON & STEEL EXPOSITION

AUGUST, 1958

TECHNOLOGY DEPT.

SEE PROGRAM ON PAGE 101

PLATE MILLS *designed and built by* MESTA



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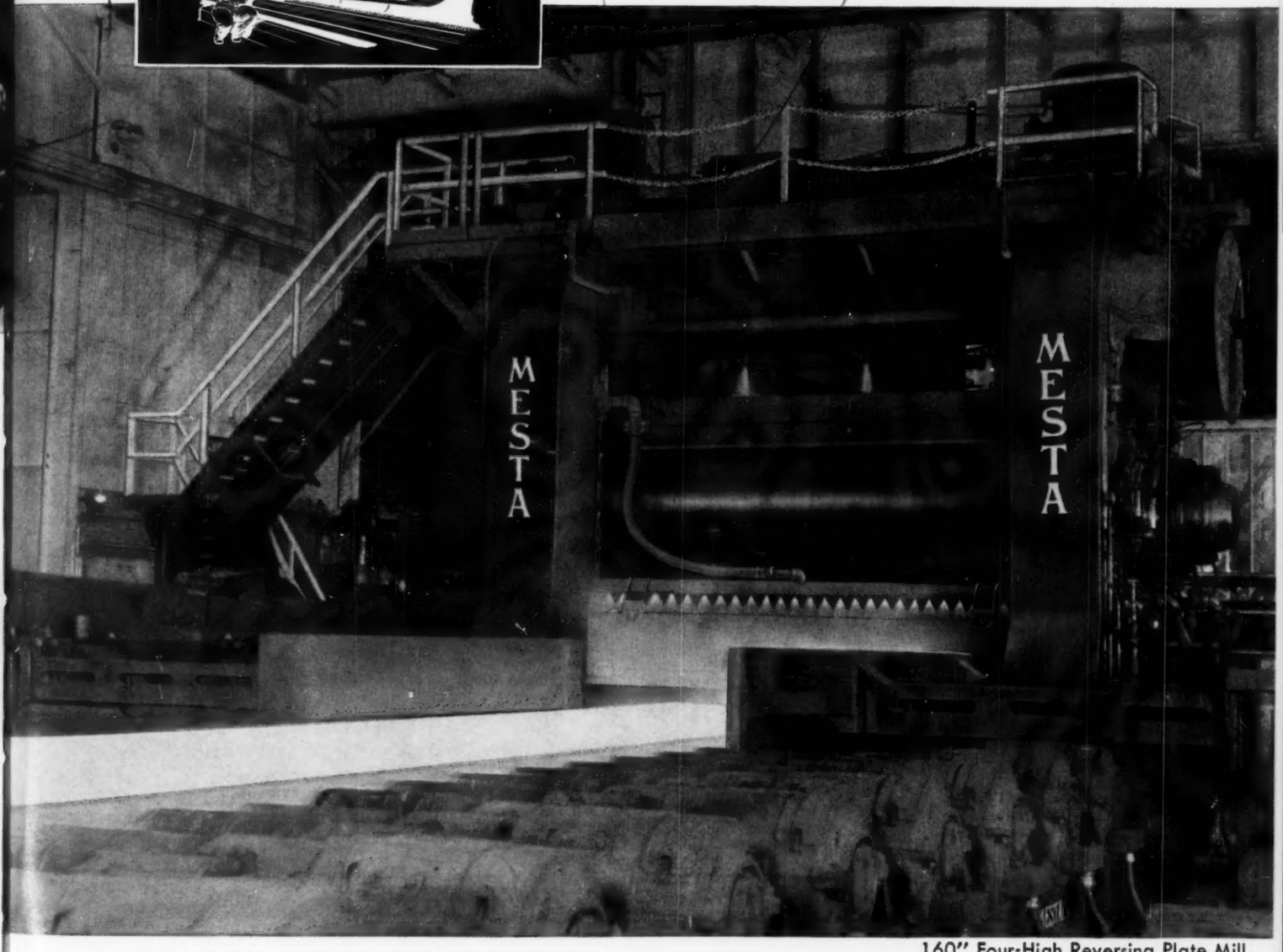
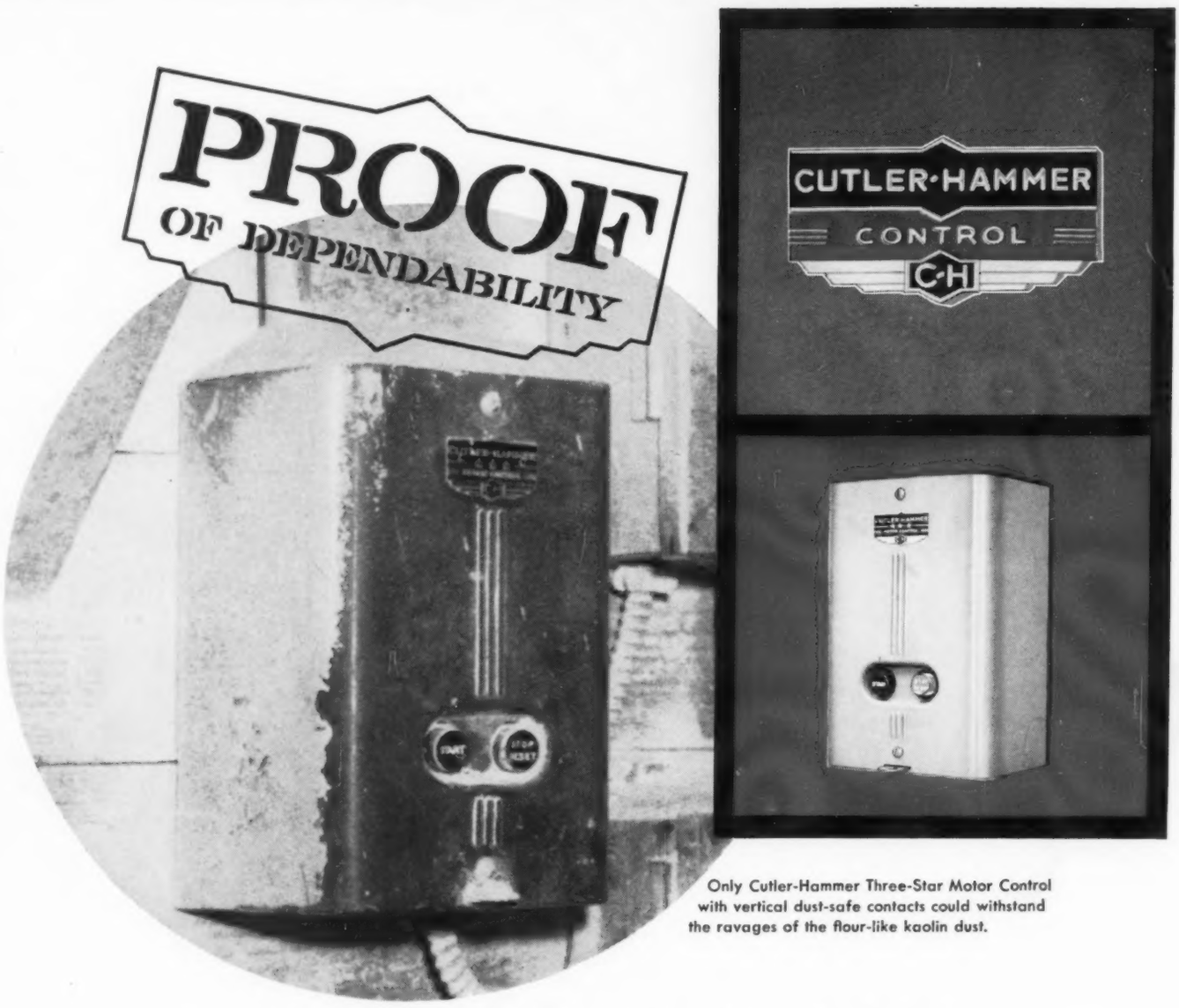
DETROIT



160" Four-High Reversing Plate Mill

MESTA *Machine Company*
Pittsburgh, Penna.

MESTA
DESIGNERS AND BUILDERS OF COMPLETE STEEL PLANTS



Only Cutler-Hammer Three-Star Motor Control with vertical dust-safe contacts could withstand the ravages of the flour-like kaolin dust.

Large Southern kaolin processing plant cuts maintenance costs with Cutler-Hammer Control

By the very nature of the product, kaolin processing is an extremely dusty operation. Because of this the electrician at a large Southern kaolin plant found it necessary to replace the dust-fouled contacts in the motor starters every 30 to 60 days. Several makes of motor control were tried, but the results were always the same . . . dust laden contacts wore rapidly requiring frequent attention.

Thirteen months ago a Cutler-Hammer Three-Star Magnetic Starter with vertical dust-safe contacts was installed, and the electrician reports perfect operation without a single contact replacement . . . no time lost for repairs.

This is positive proof of dependability . . . proof that Cutler-Hammer Three-Star Motor Control works better, lasts longer than any other on the market today. Why take chances with costly production interruptions? Order dependable Cutler-Hammer Three-Star Motor Control from your nearby Authorized Cutler-Hammer Distributor today. For complete ordering information, write for the Cutler-Hammer Merchandiser, EA-100-Q232. CUTLER-HAMMER Inc., Milwaukee 1, Wisconsin.

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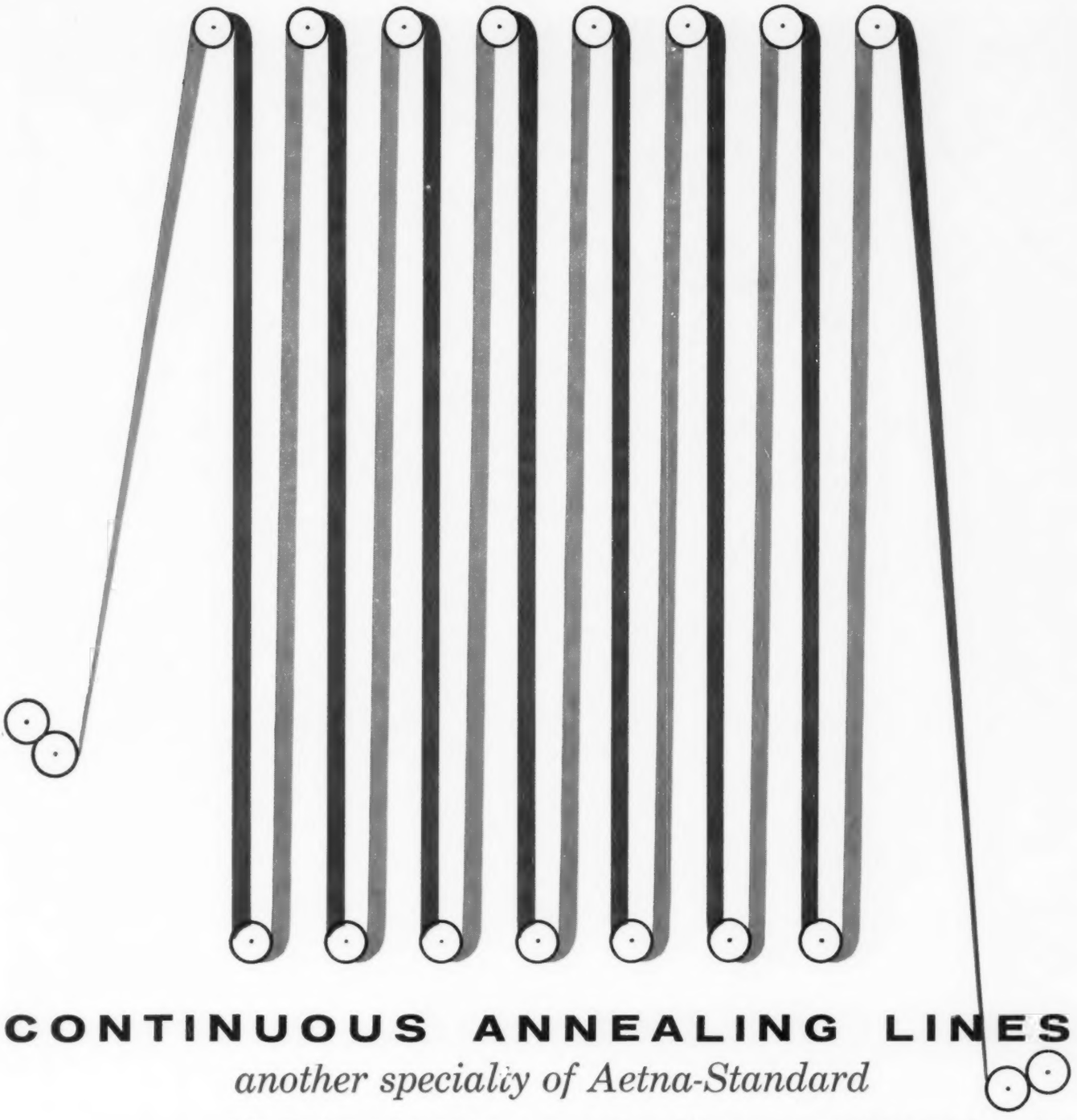
IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers at 20th and Northampton Sts., Easton, Pa. Editorial and advertising offices, 1010 Empire Bldg., Pittsburgh 22, Pa. Second-class mail privileges authorized at Easton, Pa.



CONTINUOUS ANNEALING LINES

another specialty of Aetna-Standard

Like Continuous Galvanizing or Tinning, a Continuous Annealing Line requires good designing and rugged equipment.

Aetna has much experience in continuous processing lines, galvanizing, tinning and annealing. In fact, Aetna pioneered in continuous equipment. Two of the most recent high speed Aetna lines incorporate many new ideas and innovations, permitting sure tracking at high speeds of 1,000 feet and more.

What can Continuous Annealing do for your production and your costs? Aetna's sales engineers can produce some interesting figures.

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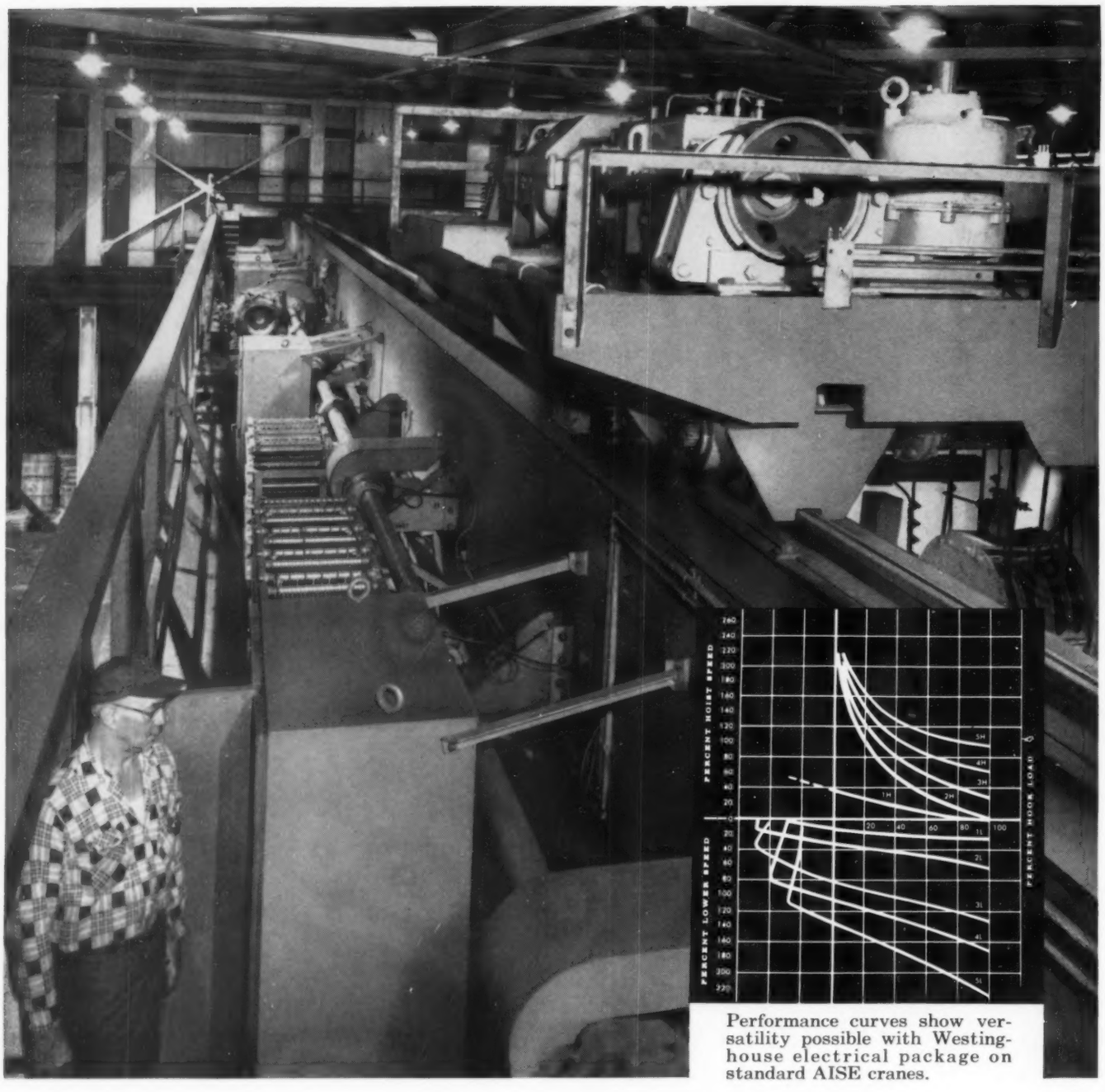
CONTINUOUS GALVANIZING LINES • CONTINUOUS ANNEALING LINES • CONTINUOUS ELECTROLYTIC TINNING LINES • SIDE TRIMMING AND SHEAR LINES AND OTHER FINISHING EQUIPMENT • CONTINUOUS BUTT WELD PIPE MILLS • SEAMLESS TUBE MILLS • DRAWBENCHES AND OTHER COLD DRAW EQUIPMENT • ROLLS AND CASTINGS • EXTRUDERS, MILLS, PRESSES FOR RUBBER AND PLASTIC



Performance curves show versatility possible with Westinghouse electrical package on standard AISE cranes.

Westinghouse electrical package for AISE cranes means better performance... less maintenance

MOTORS • CONTROL • BRAKES • GEARING

Westinghouse 600 Series silicone mill motors, self-adjusting brakes and gearing, plus front-connected and -wired front-accessible control, meet rigid AISE standards . . . assure top performance and minimum maintenance because they are designed to work together.

When you are considering new or replacement crane drives, look to Westinghouse for the exact system needed. For complete information, contact your Westinghouse sales engineer. Or, write Westinghouse Electric Corporation, P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pennsylvania.

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YOU CAN BE SURE... IF IT'S Westinghouse

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Published Monthly by

ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING PITTSBURGH 22, PENNSYLVANIA

Statements and opinions given in articles and papers appearing in "Iron and Steel Engineer" are the expressions of contributors, for which the Association of Iron and Steel Engineers assumes no responsibility.

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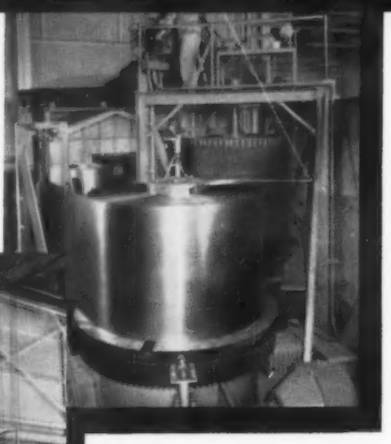
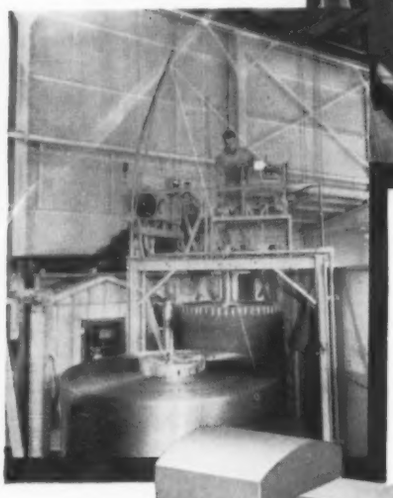
Indexed by Engineering Index and by Industrial Arts Index.

Single Copy Foreign Prepaid $2.00 (U. S. funds) Single Copy $1.50
Subscription price in U. S. and Canada (U. S. funds).....$ 7.50 per year
Subscription price in foreign countries (U. S. funds).....$10.00 per year

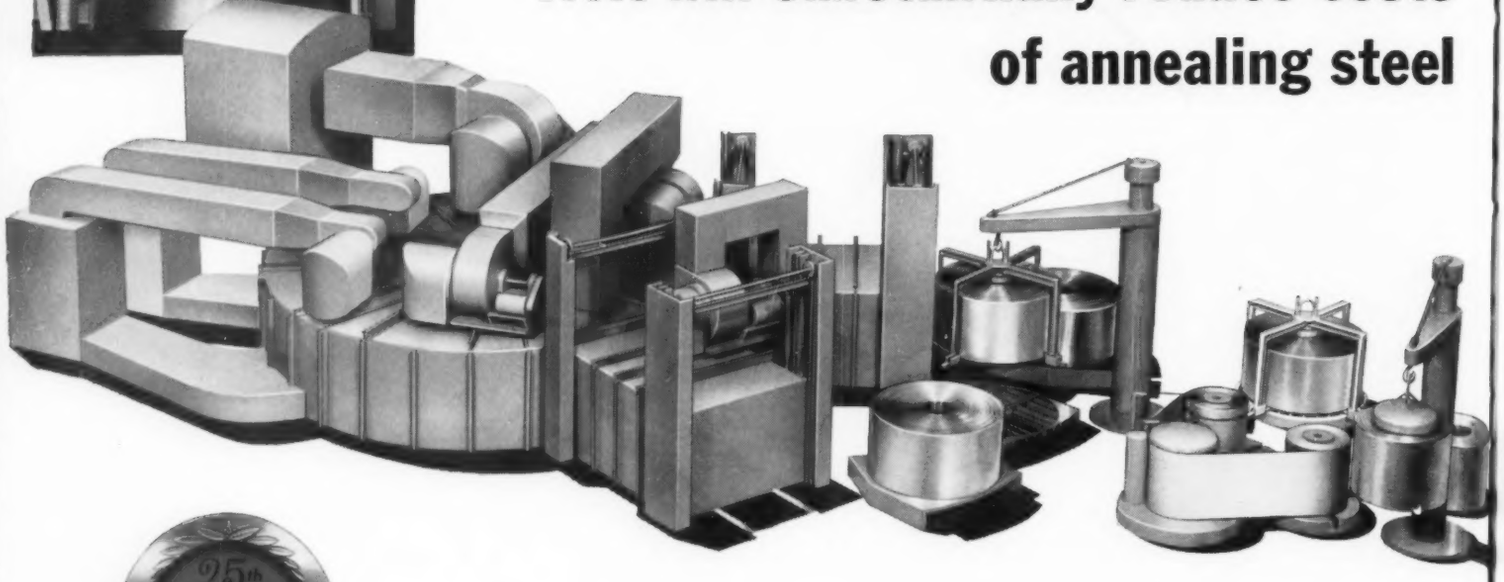


Right—Tight coil being opened. Note separator string being threaded into the coil.
Below—Separator string being removed from coil.



here it is...

the revolutionary opened coil annealer, designed by Lee Wilson ...it will substantially reduce costs of annealing steel



25th Lee Wilson ANNIVERSARY ENGINEERING COMPANY, INC. CLEVELAND

Methods of opening and handling opened coils, heart of New System

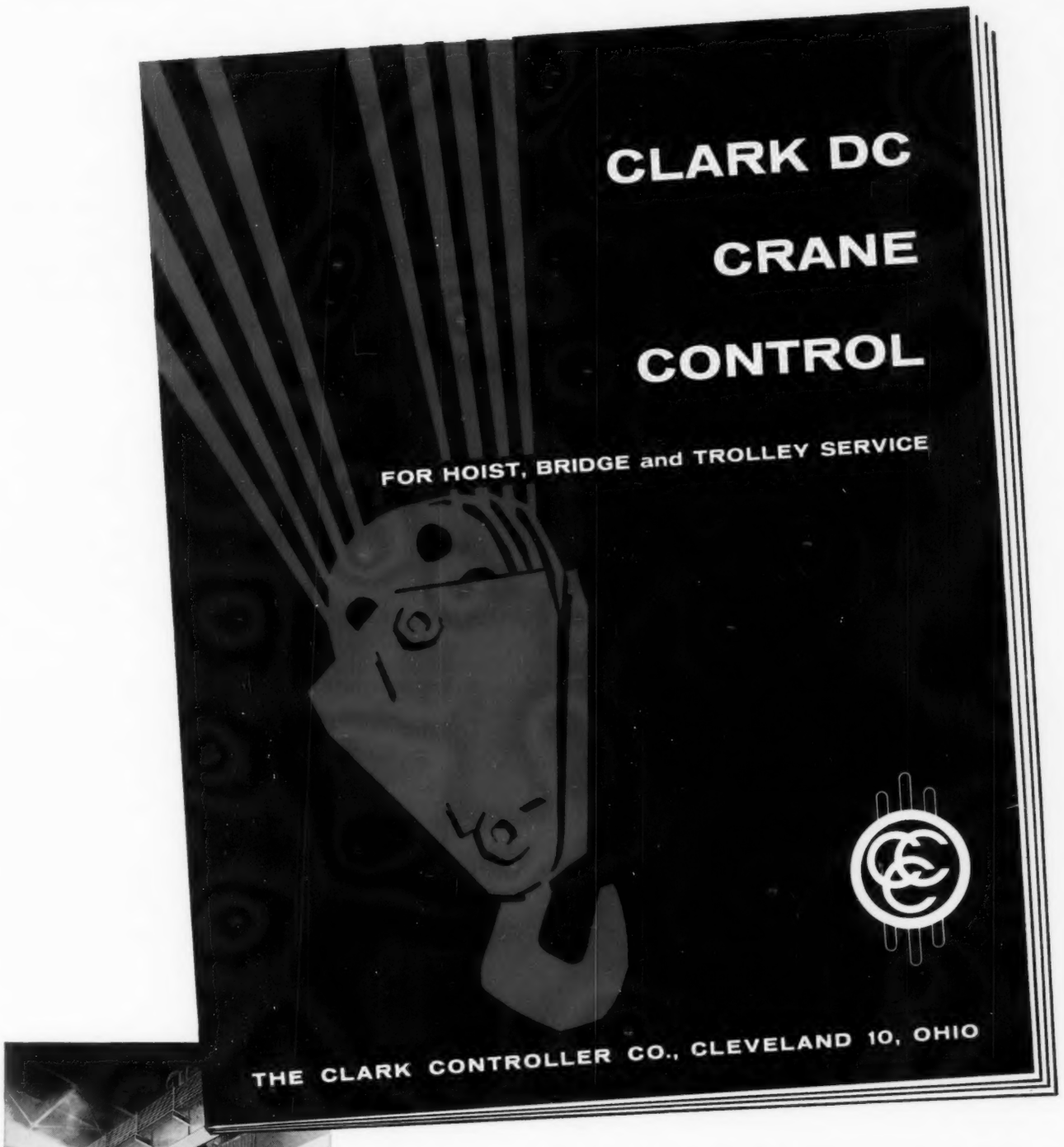
Lee Wilson engineers have developed a method for opening and handling opened coils that makes it possible to expose from 200 to 1000 times the area to heat. This means a faster, more uniform anneal. The new system, further, drastically reduces the expensive process inventory required in the annealing operation. There are many other important advantages to this revolutionary new system. Be sure you have all the facts. Write today for your copy of the Opened Coil Annealer brochure that explains the system in detail.

Opened coil being rewound into a tight coil after annealing.

2505

Lee Wilson* ENGINEERING COMPANY, INC.
20005 WEST LAKE ROAD • CLEVELAND 16, OHIO
HIGH PRODUCTION ANNEALING SYSTEMS
MAKE THE BEST METALS BETTER

* ORIGINATORS AND LEADING PRODUCERS OF OPENED COIL AND SINGLE STACK FURNACES



Clark has engineered and built control systems for all sizes and types of DC cranes, covering all five NEMA I.C1-42.01 Service Classifications. The hot ladle crane illustrated is an example of Group V, Steel Mill and Heavy Industrial.

Interested in DC Cranes?

This 20 page book outlines the basic principles of DC crane control, and provides the essential technical information you should have to select the controls best suited to your particular DC crane requirements. Profusely illustrated with photographs, charts and diagrams, the book explains in detail the circuits and components required for safe, dependable crane operation. As a major supplier of DC control of all types for over 30 years, The Clark Controller Company has pioneered and developed many of the advancements in modern DC crane control. This book provides an authoritative report of these developments.

Write today for your copy of this informative book. Ask for Bulletin 9100.

The CLARK CONTROLLER *Company* 11G

Everything Under Control 1146 East 152nd Street • • Cleveland 10, Ohio

IN CANADA: CANADIAN CONTROLLERS, LIMITED • MAIN OFFICES AND PLANT, TORONTO

Puts squeeze on steel tubes...

TIMKEN® bearings put squeeze on costs

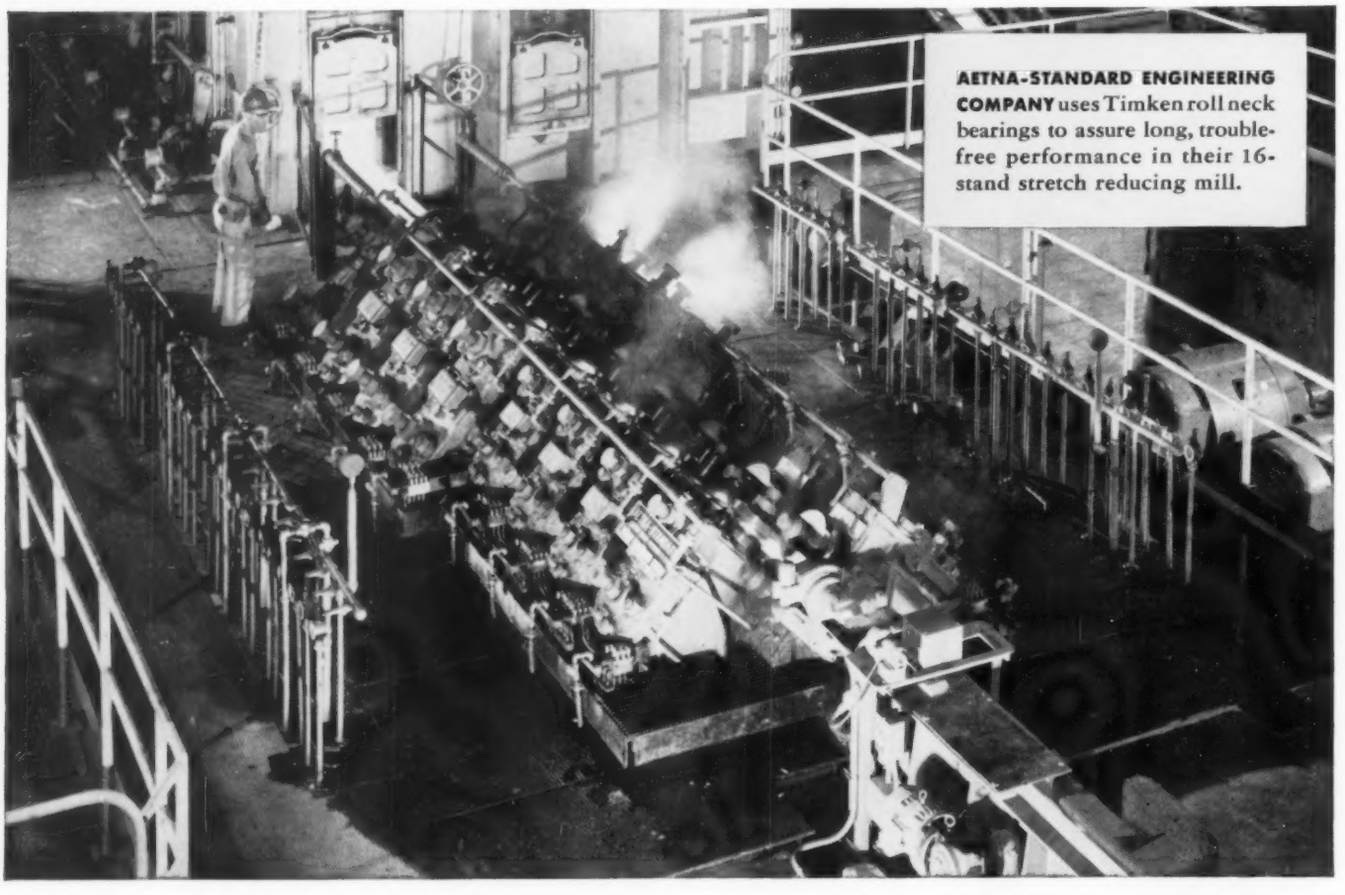
TO keep production high, downtime low, Aetna-Standard Engineering Company mounted the roll necks of their 16-stand tube stretch reducing mill on Timken® tapered roller bearings. One of the few of its kind in the world, this new mill, in operation at Jones & Laughlin Steel Corporation — Aliquippa Works, uses varying-speed rolls to reduce diameter and wall thickness of steel tubes.

Timken roll neck bearings give longer, trouble-free service because their balanced proportion design provides maximum bearing capacity in available space. And balanced proportion design means greater mill rigidity. With Timken bearings roll neck strength is increased 50% to 60% and load ratings up to 40%. Their tapered design enables them to take radial and thrust loads or any combination. No expensive thrust devices are needed.

Mills with Timken bearings can be started under full load. No steel is wasted because of disturbed gauge settings. Higher rolling speeds are possible because Timken bearings are designed for economical grease lubrication. Rolls can also be changed faster.

Why not get all these advantages in the machines you buy or build? Or in existing machines? Timken balanced proportion roll neck bearings can reduce downtime, cut costs for you, too. For full information, consult our roll neck specialists. Write The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



AETNA-STANDARD ENGINEERING COMPANY uses Timken roll neck bearings to assure long, trouble-free performance in their 16-stand stretch reducing mill.

TIMKEN *TAPERED ROLLER BEARINGS ROLL THE LOAD*

TRADE-MARK REG. U. S. PAT. OFF.

Unmasking a Myth* about OXYGEN

the Myth:

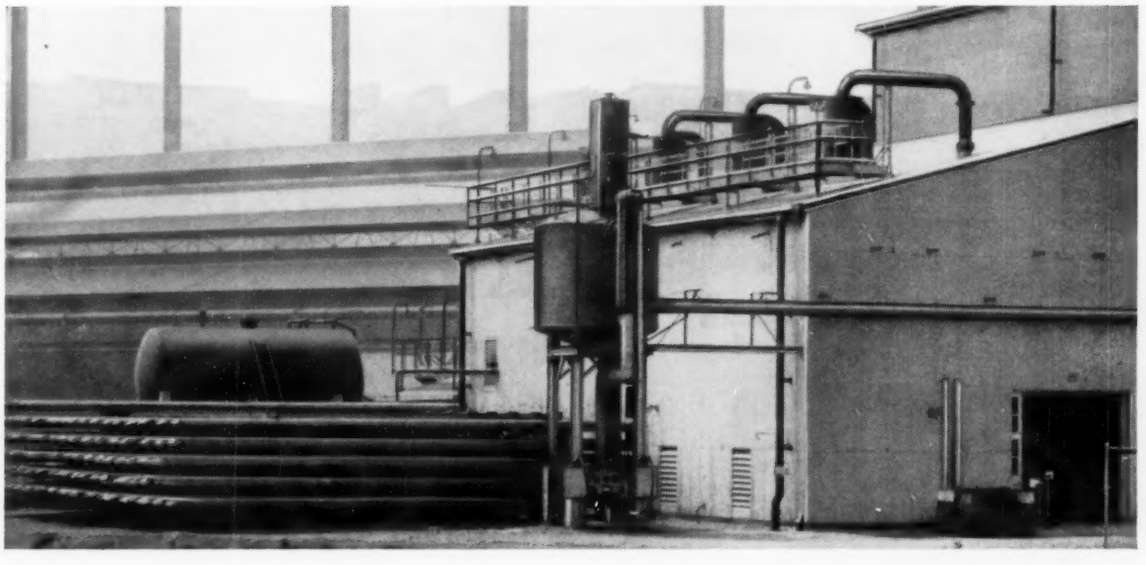
Changing oxygen load requirements cannot be met effectively by on-site generation.

the Fact:

On-site installations can meet, economically, variations in production which are usually wider than oxygen utilization equipment can handle.

the Reason:

Many oxygen generators may be operated over a wide range of capacities from 40% to better than 110% of rated capacity. Multiple generator systems extend this latitude considerably. Integrated storage systems permit high peaks and deep valleys in usage curves, while generators operate within convenient, economical ranges of output.



Air Products has proven the fallacies of many myths about oxygen generation and use. For all your needs . . . oxygen, nitrogen, argon and hydrogen . . . Air Products offers flexible supply systems erected on your property or immediately adjacent, available at guaranteed cost and no capital investment.

For the best answer to your gas supply needs, contact Air Products today at Allentown, Pa.

*myth (mith), n. 1. A story, the origin of which is forgotten, ostensibly historical but usually such as to explain some practice, belief, institution, or natural phenomenon. (by permission from Webster's New Collegiate Dictionary © 1956, by G. & C. Merriam Co.)

Air Products ...INCORPORATED

How to spend less for expendables

Day after day, week after week, your instruments steadily use up charts, inks, thermocouple wires, tubes, wells—all the expendable accessories that require regular replacement.

If you've been buying your supplies on a hand-to-mouth basis, you're missing out on some sizable savings. Honeywell has developed a modern purchasing plan that gives you new economy, convenience, and quality. This new plan provides assistance in selecting the right supplies and sets up a custom-fitted schedule for buying that will cut your inventories, simplify your purchasing, and save you a big percentage of your annual bill.

New HSM Plan

Foundation of this new plan is your Honeywell Supplies Man. He is trained in the Honeywell factory and has a broad and thorough knowledge of instrumentation. A full-time supplies specialist, your HSM gives you personalized, expert service.

These men are strategically stationed throughout the country to serve you. They will help you plan your purchases to get maximum quantity discounts . . . keep your inventories balanced and always up to date.

Here's how the plan works

1. ***Survey plant***—Your Honeywell Supplies Man checks annual consumption of each supply item in your plant and establishes minimum inventory needs.

2. ***Detail requirements***—He then shows you what you can expect to purchase during the coming year to keep adequate stocks on your shelves.

3. ***Assist in selection***—He keeps you up to date on newest developments, and recommends specific types of equipment wherever your present buying can be improved.

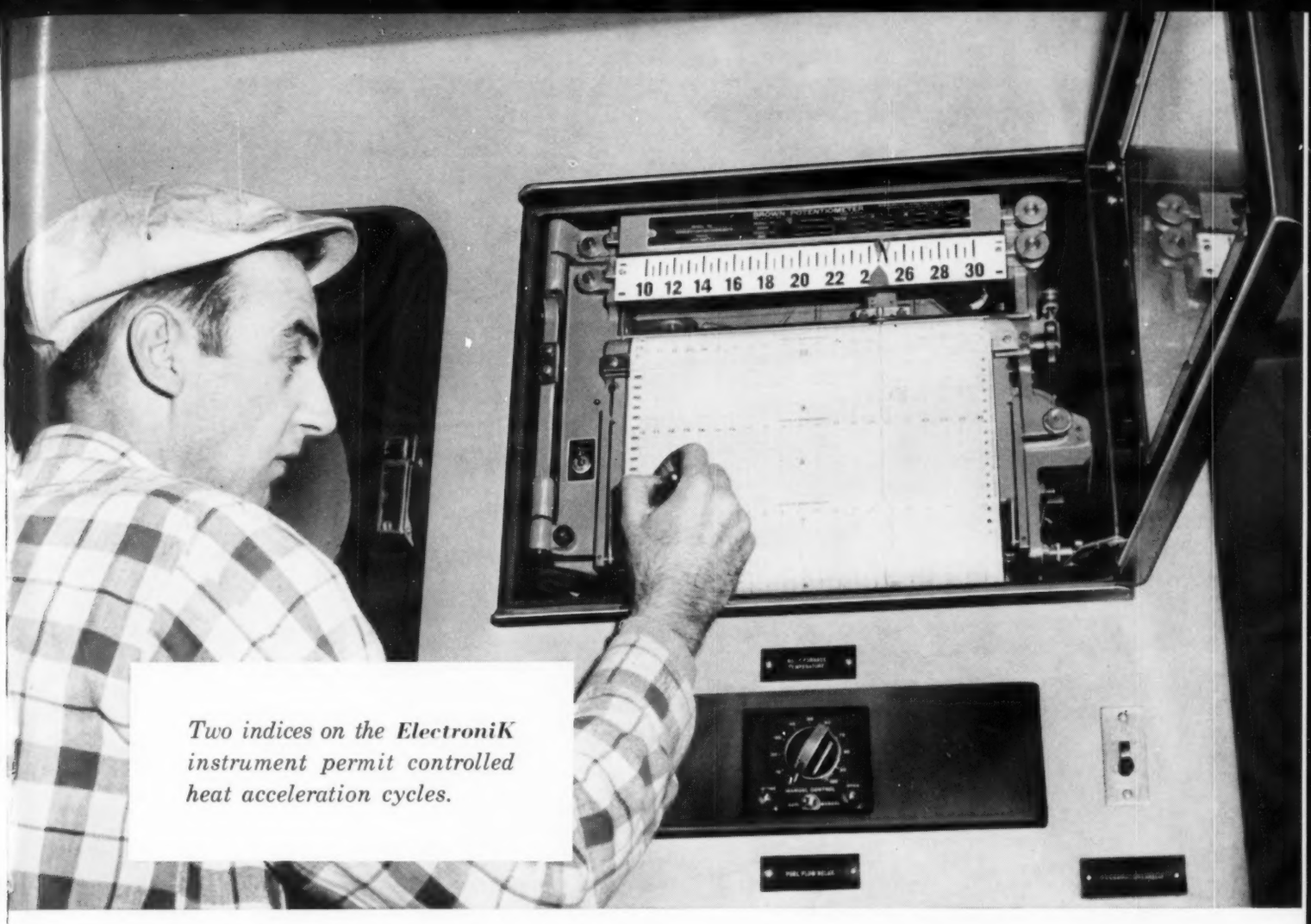
4. ***Estimate savings***—Next, he prepares a blanket annual order, grouping like items to get the biggest quantity discount. Savings may run as high as 50%.

5. ***Schedule deliveries***—Finally, he arranges a regular delivery schedule that assures that you will always have adequate supplies on hand.

Give your Honeywell Supplies Man a call. He's at your local Honeywell office . . . as near as your phone.

Waste gases recirculated, pit operations improved at Fa

An evenly heated ingot is withdrawn from a Honeywell-controlled soaking pit furnace at U. S. Steel's Fairless Works.



Two indices on the ***ElectroniK*** *instrument permit controlled heat acceleration cycles.*

Fairless . . . by *ElectroniK* controls

Soaking pit instrumentation by Honeywell is paying off at U.S. Steel's Fairless Works near Morrisville, Pa. An *ElectroniK* strip chart controller with *Electr-O-Line* control unit regulates the recirculation of hot waste gases from soaking pit furnaces supplied by Loftus Engineering Corporation. With waste gases at work together with fuel gas, the volume of gases flowing through the pits is maintained at a relatively constant level. Results: better distribution and use of heat, less soaking time.

Recirculation of waste gases occurs as pit temperature reaches the control point. The operator switches a manual reset control unit into the system, opening the waste gas valve proportionately over a 30 percent band as the fuel gas valve starts to close.

Honeywell instrumentation gives Fairless another major advantage: *heat acceleration*—the temporary elevation of pit temperature to a higher-than-normal limit for extra-fast heating of ingots. The *ElectroniK* controller has two indices which are normally set about 50 degrees apart. During normal operations, temperature is held at the lower index. To accelerate heating, the operator sets a timer, then pushes a button. Immediately, the fuel gas valve opens and the upper index takes over control. At the end of the timed cycle, control reverts to the lower index.

In your own plant, versatile Honeywell instrumentation can make profitable improvements in processes and products. Find out how from your nearest Honeywell sales engineer. He's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA:** Write for Catalog C15-2—"*ElectroniK* Controllers".

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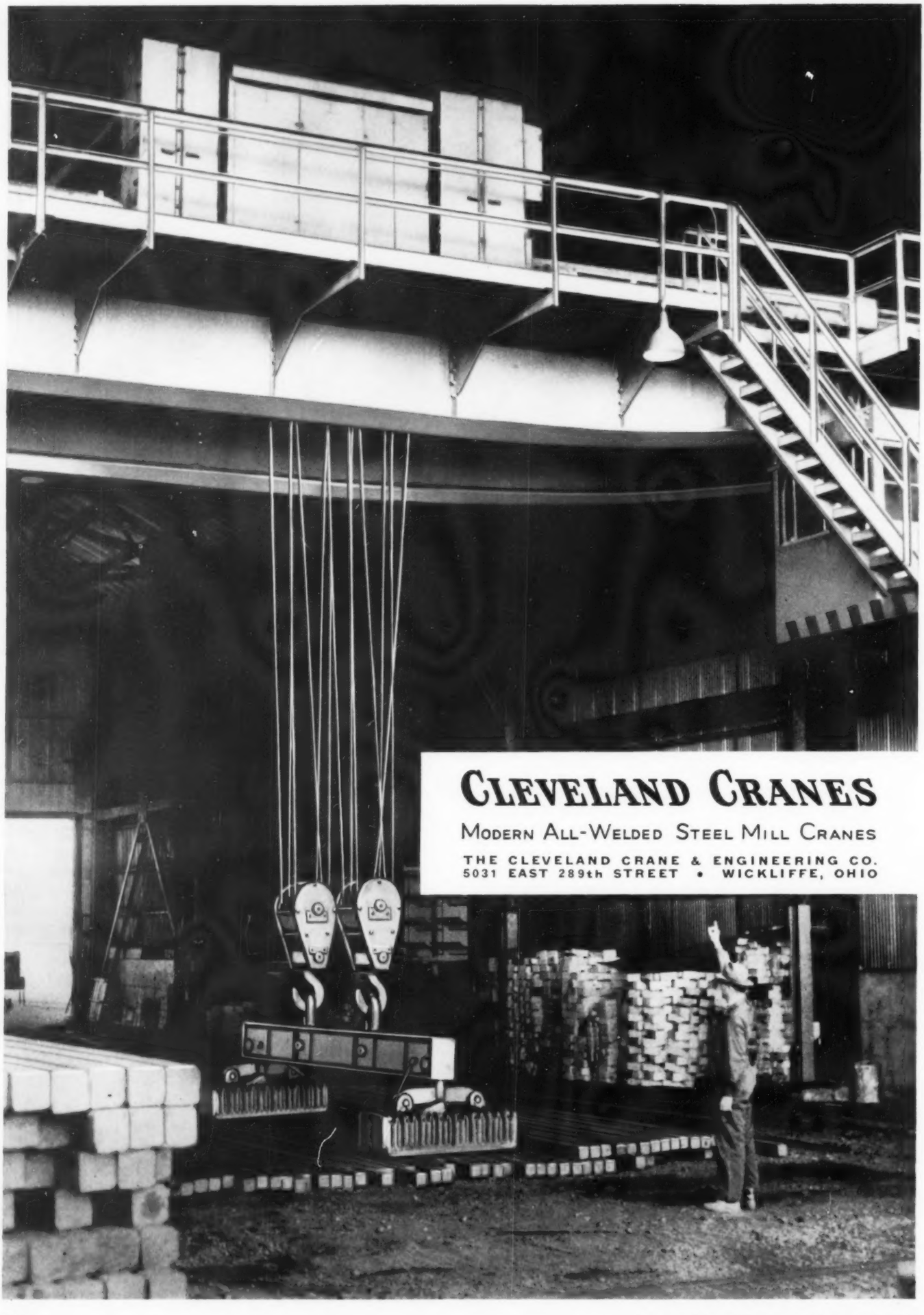
First in Control


CLEVELAND CRANES
MODERN ALL-WELDED STEEL MILL CRANES
THE CLEVELAND CRANE & ENGINEERING CO.
5031 EAST 289th STREET • WICKLIFFE, OHIO

Crops *and* Shorts

Δ A recent McGraw-Hill survey paints a rosy picture for 1975: Population of 235,000,000; a 94,000,000 labor force; output per manhour up 55 per cent; a 35-hour work week; a gross national product of $835,000,000,000; $585,000,000,000 consumer expenditures; $100,000,000,000 for construction; business capital expenditures of $70,000,000,000; $15,000,000,000 for research and development; 9,000,000 passenger cars per year; steel production of 175,000,000 tons per year; petroleum usage up more than 85 per cent; electric power consumption quadrupled; per capita income 40 per cent above the 1957 level.

And some of us old guys are going to miss all this!

Δ Erection is beginning on the first aluminum girder type highway bridge in the world. Located near Des Moines, Iowa, the bridge is a four-span continuous structure, 222 ft long, 36 ft wide, with reinforced concrete deck. It is a developmental project jointly sponsored by the Iowa State Highway Commission and the major aluminum producers.

Δ The American Rocket Society predicts manned flights around the earth within 10 years, flight around the moon in 15 years, and return trips to the moon within 20 years.

Anyone want to go along for the ride?

Δ Lehigh University reports the average starting salary of its 1958 engineering graduates at $474 per month, up $9 over the 1957 figure.

Δ A recent announcement stated that automobile builders are spending big money to build up research and development groups to compete with aircraft manufacturers in space missiles.

At last, it's out! Some of us who have been wondering about the designs of today's autos are convinced the designers got crossed up. As one cynic puts it, since the auto industry has troubles getting its products onto the highways, it's aiming at space.

Δ A friend of ours doesn't agree that the blame for the automobile market doldrums belongs on the freakish design and ornamentation of today's models. He claims the greatest obstacle is the payments still due on the 1957 and 1956 models.

Δ An outgrowth of World War II government contracts for defense production is a large patent pool, administered by the Office of Technical Service, containing numerous patents available to American business at little or no cost.

Δ In spite of apparent opinion to the contrary, thrift is a wonderful thing, and we only wish our ancestors had practiced it more.

Δ Before you get feeling too expansive, remember that net public and private debt in the United States totaled $726,000,000,000 at the end of 1957, up 74 per cent over the 1947 figure.

Δ The house organ, The William Feather Magazine, says "Not a tenth of what is thought is ever said." We'd like to add "and it would be better if half of what is said wasn't."

Δ The National Society of Professional Engineers states that about 40,000 professional engineers and scientists are represented by unions in the United States, of which not more than 30,000 are dues-paying members.

Δ Prohibitionists can take heart. Sales of distilled spirits in the United States in 1957 totaled 212,018,101 gallons, compared with 215,261,108 gallons in 1956—a drop of about 1.5 per cent.

Δ Inland Steel's 25-year club now has a membership of 3282 out of a total plant employment of 19,000. William A. Perry, a 49-year man, is president.

Δ We note that the board of directors of AIME has decided that element 41 shall henceforth be called columbium. In this, the directors are at variance with the International Union of Pure and Applied Chemistry, the American Chemical Society and the National Research Council, who nine years ago decided in favor of niobium.

We don't want to take sides in this dispute. If such things come to be decided by board action, we might be forced to drink hydrogen oxide or a mixture of ethanol, treat our morning egg with sodium chloride, wear braces to hold up our trousers and suspenders to hold up our hose. We might have to ride the tram or underground to work. We might even have to eat tomatoes instead of date 'em.

Δ There was a time when "lubrication" carried a connotation of oil or grease. Then came composition bearings, bringing water into our "lubricant" thinking. Now comes a mixture of air and jet engine fuel lubricating high temperature ball and roller bearings, and even air or other gases alone.

When it comes to air, we can't help wondering whether the argument between brand names and specifications will still be with us.

Δ The iron and steel industry will be saluted by Alex Dreier, radio and TV commentator, during a nationwide radio program Sunday, September 14, over NBC-Monitor. The program will be broadcast at 6:05 p.m. New York time, over the entire NBC network of nearly 200 stations. Dreier's tribute will tie in with the Iron and Steel Exposition and the convention of the Association of Iron and Steel Engineers which begins September 23 at the Public Auditorium in Cleveland, Ohio.

We would suggest that you hear him—and then plan to be at Cleveland, too.

Johns-Manville Insulating Fire Br

put physical and thermal properties *in proper balance!*

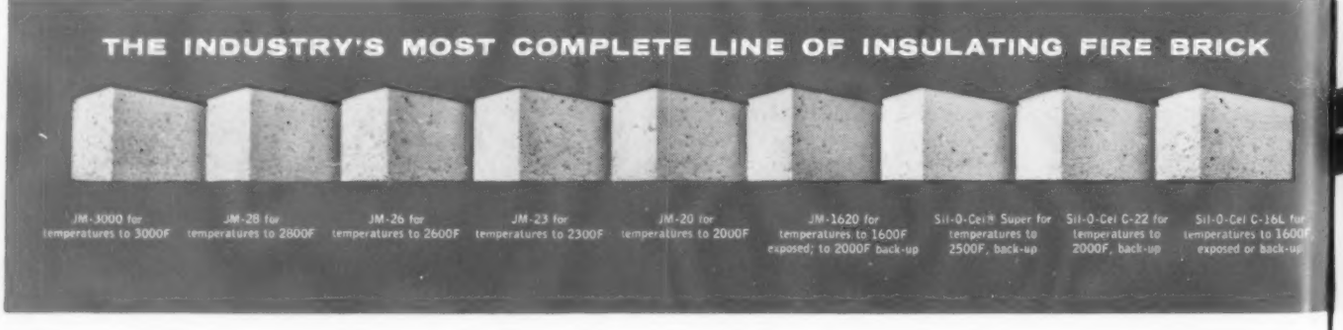
... provide essential high-temperature resistance and low conductivity... yet maintain high load-bearing strength with low spalling!

Only Johns-Manville's insulating fire brick family offers the right combination of properties to meet the diversified requirements of modern furnace construction.

Johns-Manville's nine different insulating fire brick mean you never have to settle for a brick that's nearly right! Instead you choose the one insulating fire brick or combination of brick that best meets your specific requirements for temperature resistance, load-bearing strength, conductivity and density.

Johns-Manville has two strategically located plants for the production of insulating fire brick: Lompoc, California and Zelienople, Pennsylvania. Insulating fire brick and other Refractory Products are available from the stocks of Authorized J-M distributors in key industrial areas.

For further information, call your nearest J-M representative. Or write for brochure IN-115A to Johns-Manville, Box 14, New York 16, N.Y. In Canada, Port Credit, Ontario.


THE INDUSTRY'S MOST COMPLETE LINE OF INSULATING FIRE BRICK
JM-3000 for temperatures to 3000F
JM-28 for temperatures to 2800F
JM-26 for temperatures to 2600F
JM-23 for temperatures to 2300F
JM-20 for temperatures to 2000F
JM-1620 for temperatures to 1600F exposed; to 2000F back-up
Sil-O-Cel® Super for temperatures to 2500F, back-up
Sil-O-Cel C-22 for temperatures to 2000F, back-up
Sil-O-Cel C-16L for temperatures to 1600F, exposed or back-up

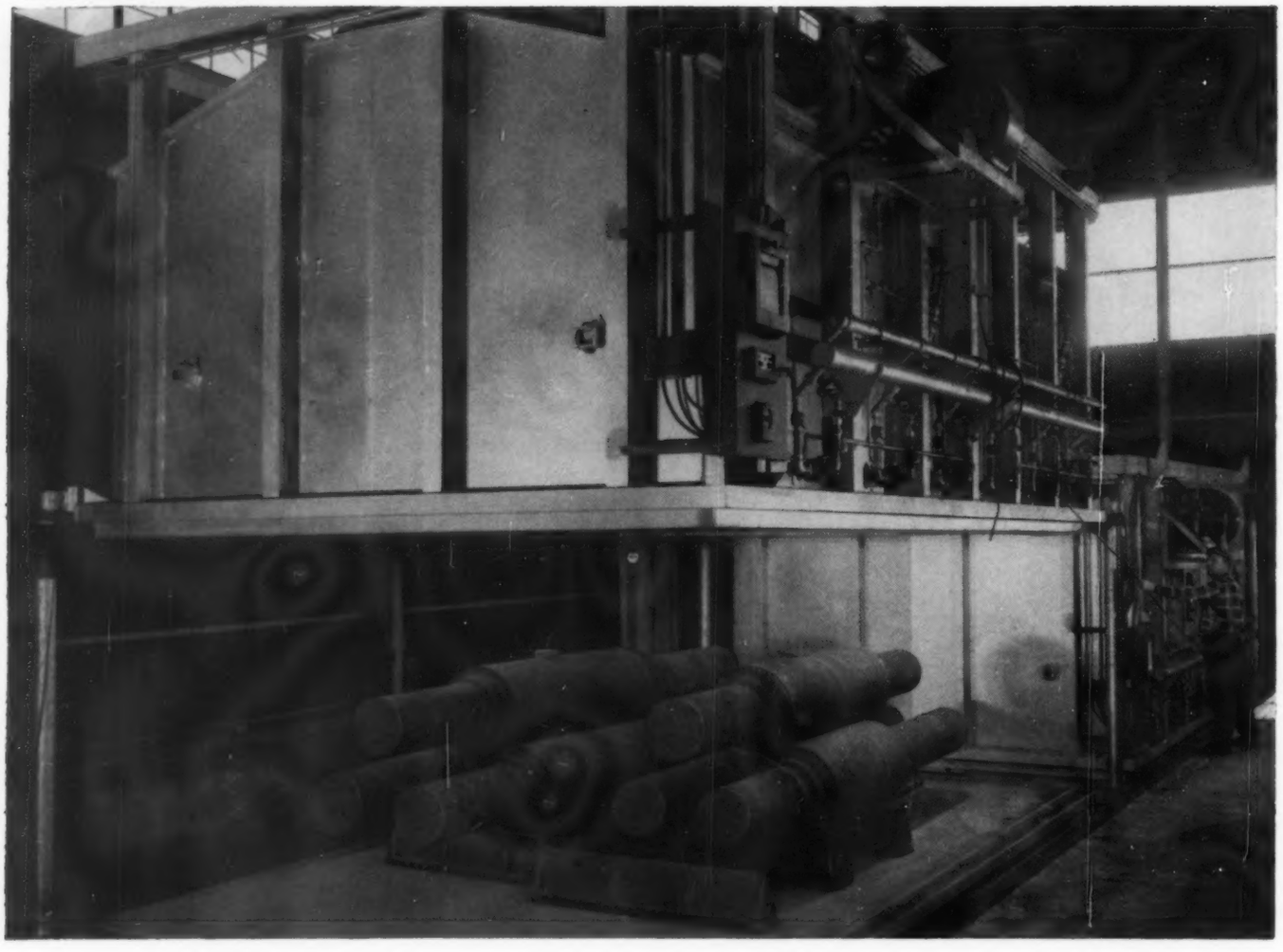
JOHNS-MANVILLE JM PRODUCTS

Johns-Manville REFRACTORY and NS

INSULATING REFRACTORY PRODUCTS

PROGRESS IN ROLL MAKING

annealing iron and steel rolls



NEW ANNEALING FURNACES

. . . for heat treating iron and steel rolls have been installed at National. These new program controlled annealing furnaces, in addition to the previously installed battery of six automatic zone control, car type heat treating furnaces, enable National Roll & Foundry Division to heat treat your iron and steel rolls to the exact degree required for long tonnage life in your stands.

These annealing furnaces are another example of what's new at National—new buildings, new equipment, new ideas—all part of the expansion and modernization program designed to give you better iron and steel rolls.

GENERAL STEEL CASTINGS CORPORATION

National Roll & Foundry Division

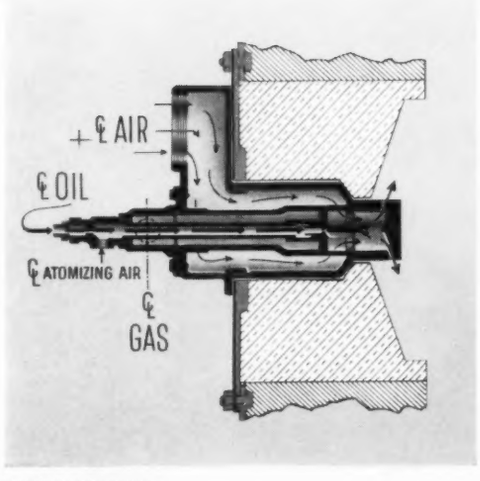
Avonmore (Westmoreland County) Pennsylvania

General Steel Castings Corporation: General Offices, Granite City, Ill. • Plants: Granite City, Ill.—Eddystone, Pa.—Avonmore, Pa.

for intense concentration of heat . . .

The BLOOM HTR BURNER

The Bloom HTR Burner provides identical operation on either gas or oil.

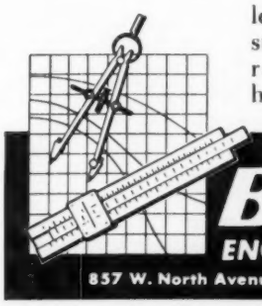


PATENT PENDING

This burner enables the engineer to design a heat pattern with excellent results, because it has the unique characteristic of providing localized high heat release with low forward velocity. The burner can be located to fire directly at the material without flame impingement. Roof firing is easily accomplished and provides uniform hearth temperature.

This burner has been very successful in its application to tube upset furnaces; continuous strip annealing, coating, and pre-heating lines; high speed billet heating furnaces; and batch-type forge furnaces.

The Bloom High Thermal Release Burner with its sturdy construction is ideal for applications requiring speed and precision heating.



BLOOM
ENGINEERING CO., INC.
857 W. North Avenue Pittsburgh 33, Pa.

ALCOA HAS THE RIGHT COMBINATION

For 15 years, Alcoa has lived with leading engine and equipment builders and bearing manufacturers to solve their bearing problems. From this experience, we learned that the ideal bearing material can't excel in one way and fail in another. For example, a bearing material must be hard enough to withstand wear, yet soft enough to embed; strong enough to carry heavy loads, yet ductile enough to conform. In short, the best bearing material must have the right combination of features to meet demands from many directions.

We were certain from the start that aluminum, because of its inherent properties, must hold the answer, and so we

launched a long series of tests. After more than 400 different aluminum alloys had been tried, we found the ones we wanted: the aluminum alloys with the right combination of advantages. These Alcoa® Aluminum bearing alloys are now used in solid cast aluminum bearings that:

Withstand Heavy Loads . . . up to 10,000 psi on projected area.

Run Cooler . . . Because aluminum is the best heat conductor among bearing materials, aluminum bearings run cooler . . . as much as 20° by actual test.

Conform Readily . . . Aluminum has good ductility, conforms readily to misaligned shafts and nonparallel pins to reduce unit loading, extend bearing life.

Have Ideal Embeddability . . . Aluminum embeds dirt particles better than bronze, but not as deeply as babbitt; particles roll out easily and are trapped by filters.

Resist Corrosion . . . Aluminum bearings are unaffected by corrosive additives in oils and need no protective coatings.

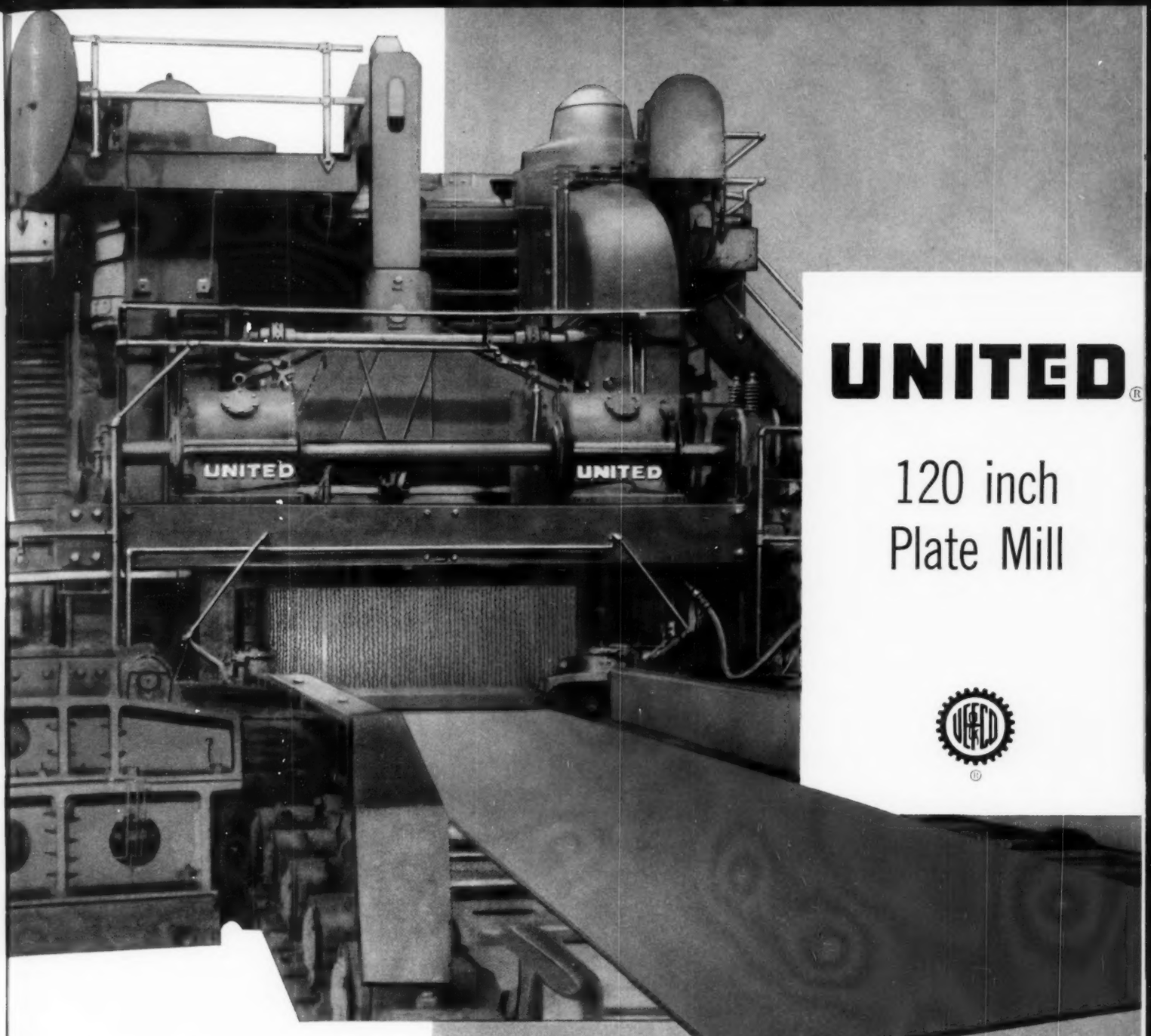
Offer Design Flexibility . . . Aluminum's combination of structural properties allows great flexibility in design.

Why not have the right combination of features working for you in all your bearing requirements? Call your nearest Alcoa sales office for further information. Or, write Aluminum Company of America, 1983-H Alcoa Building, Pittsburgh 19, Pennsylvania.

ALCOA ALUMINUM BEARINGS

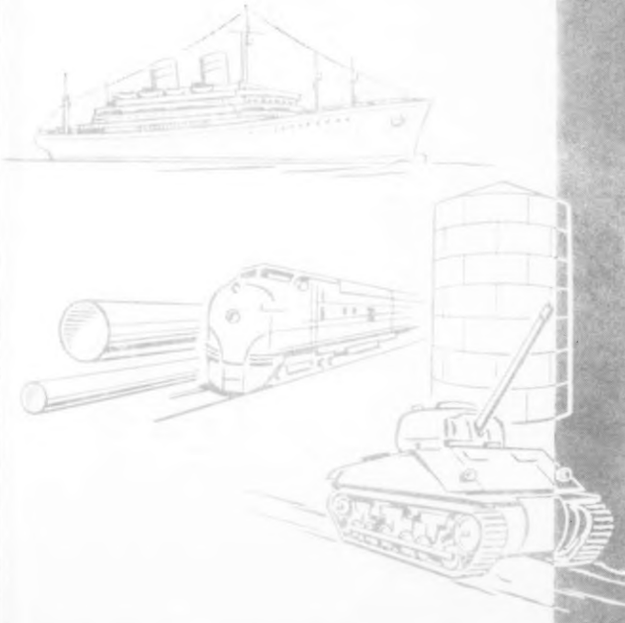
Your Guide to the Best in Aluminum Value

"ALCOA THEATRE"
Exciting Adventure
Alternate Monday Evenings



UNITED®

120 inch Plate Mill



UNITED

ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

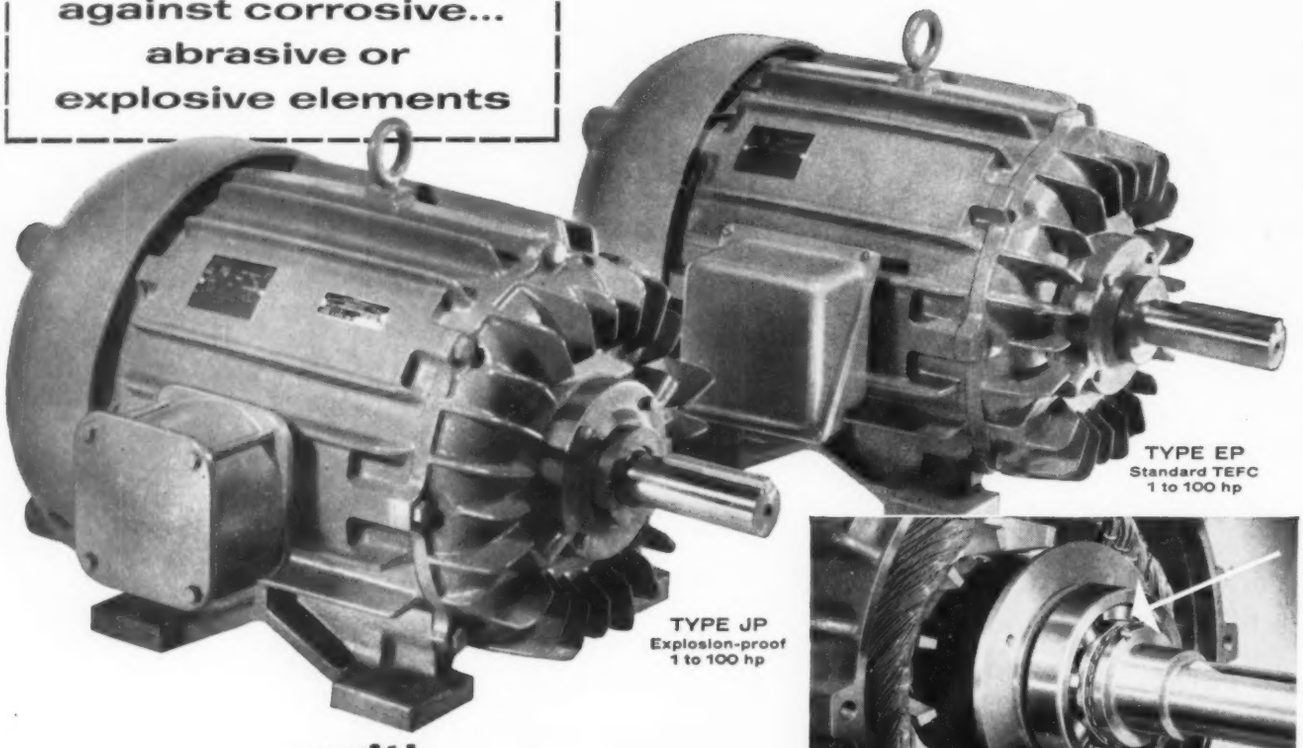
Plants at: PITTSBURGH • VANDERGRIFT • YOUNGSTOWN • CANTON • WILMINGTON

Subsidiaries: ADAMSON UNITED COMPANY, AKRON, OHIO
STEDMAN FOUNDRY AND MACHINE CO., INC., AURORA, INDIANA

Designers and builders of Ferrous and Nonferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other Heavy Machinery. Manufacturers of Iron, Nodular Iron and Steel Castings, and Weldments.

UNITED *can serve you no matter where in the world you are.*

YOU GET
EXTRA PROTECTION
against corrosive...
abrasive or
explosive elements



TYPE EP
Standard TEFC
1 to 100 hp

TYPE JP
Explosion-proof
1 to 100 hp

with

Wagner totally enclosed motors...protected for longer motor life

If you need motors that will keep production rates up . . . that will give the continuity of service that is so important to automation . . . that will operate with complete dependability under the most severe conditions—Wagner totally-enclosed motors are your soundest choice.

Type EP Motors offer protection against corrosion, dust, abrasives, fumes, steel chips or filings. Type JP is explosion proof as well—designed and approved for use in explosive atmospheres.

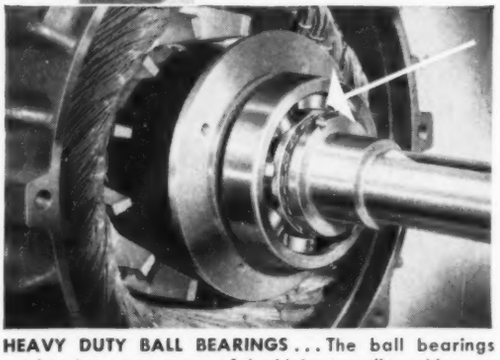
NEW NEMA FRAMES . . . These motors are built in the new NEMA Frame sizes from 182 through 445U, with ribs that add mechanical strength and increase the surface cooling area. Effective cooling system adds to motor life. Let your Wagner Sales Engineer show you how these protected motors can bring you savings on initial motor costs, maintenance costs and continuity of operation.

1 TO 100 HP—4 POLE, 60 CYCLE—
NEMA FRAMES 182 THROUGH 445U

Wagner Electric Corporation
6483 PLYMOUTH AVENUE, ST. LOUIS 14, MO., U. S. A.

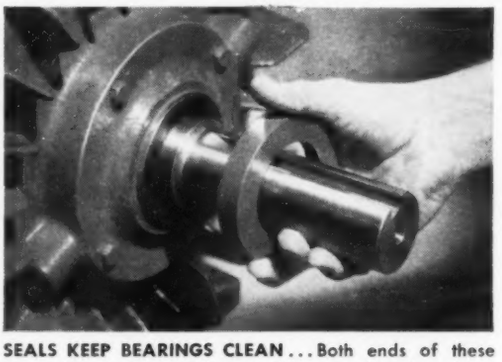
WM58-5

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES



HEAVY DUTY BALL BEARINGS . . . The ball bearings used in these motors are of the highest quality, with more than ample capacity to provide long troublefree service under heavy loads.

BEARINGS CAN BE RELUBRICATED . . . Factory installation will last for many years under normal service, but openings are provided to permit relubrication that adds years to motor life under severe conditions.



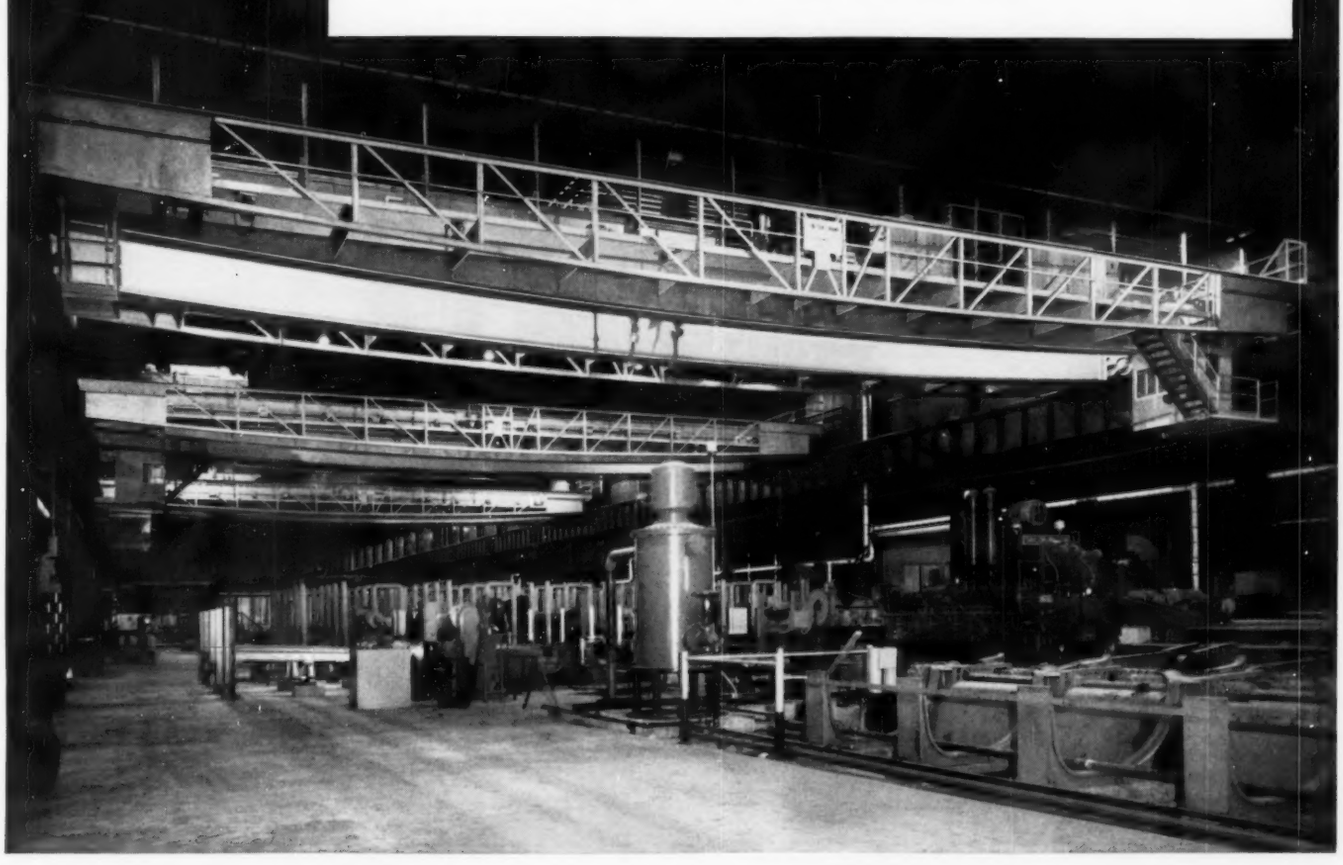
SEALS KEEP BEARINGS CLEAN . . . Both ends of these motors have running shaft seals to keep the bearings clean. Bearing housings are effectively sealed to prevent escape of grease.

AMERICA'S LARGEST STEEL MILLS USE BROWNING CRANES

Built to A. I. S. E.
Specifications or Your Own

For years, Victor R. Browning & Co. has devoted major time and study to the building of heavy duty mill cranes. The finest materials and workmanship go into the construction of these cranes. All shafts are of the highest quality alloy steel. All bearings are calculated with a proper life factor as required by the A. I. S. E. We will design to suit your special requirements or build to your specifications . . . Victor R. Browning & Co. also makes a complete line of trolleys which can be adapted to existing bridges.

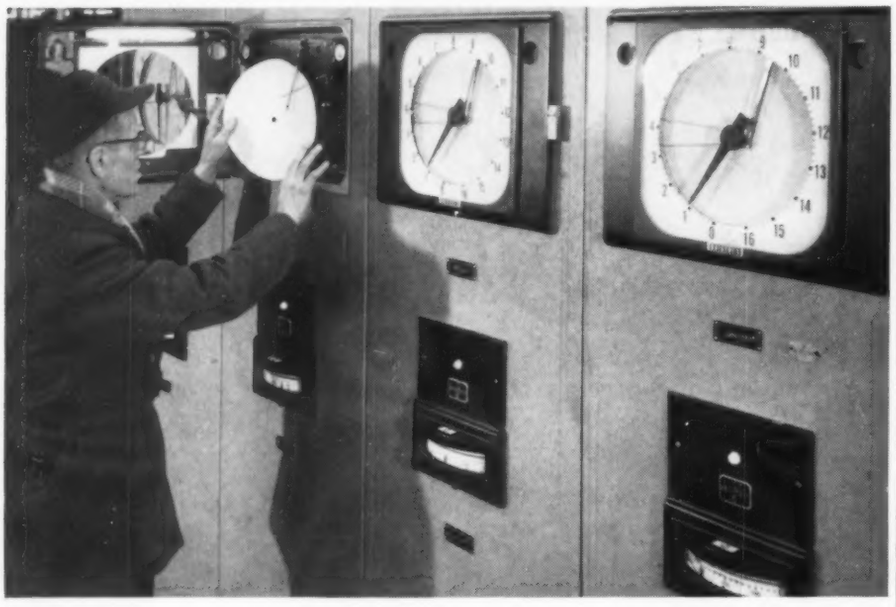
VICTOR R. BROWNING & COMPANY, INC.
WILLOUGHBY (CLEVELAND), OHIO



BRISTOL'S

Instrumentation News

• News of instrumentation and automatic control in industrial heating and metallurgy •



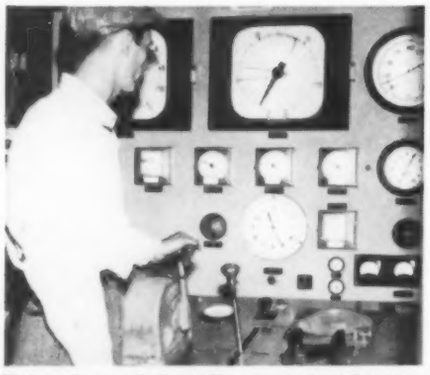
Instruments help turn out casting cores at 7 tons/hour

Engine blocks for Ford and Mercury automobiles are cast with strictest attention to accuracy and structural quality at the Cleveland foundry of the Ford Motor Company, Brookpark, Ohio, just outside Cleveland.

Yet these rigorous requirements must not impede the smooth flow of the production line. That's one reason Ford installed this battery of Bristol Dynamaster* instruments.

Another: In the early days, core baking used to be an all-night process. Cores were of fine quality, but the output was too low for present-day production lines. The new core baking method turns out top quality cores at the rate of 7 tons an hour. Bristol instruments automatically hold the baking temperature to 450° ± 5°F. And, in emergencies, allow faster processing by raising the temperatures and increasing conveyor speed.

First oxygen steel plant uses Bristol controls



Bristol round chart Dynamaster* Instruments (top) and Bristol Metagraphic miniatures (center row) play a big part in controlling oxygen steel-making at Dominion Foundries & Steel, Ltd.

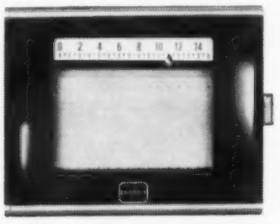
When Dominion Foundries & Steel, Ltd. (Dofasco), at Hamilton, Ontario, first introduced this method of steel-making to the North American Continent, they chose Bristol instruments and controls (above) to supervise the most critical steps in the process.

These include oxygen pressure and flow (current rate and total), lance position, lance cooling water temperature, flow, and pressure as well as various other temperatures.

The big advantage of oxygen steel-making is the lower original investment in equipment. Only about 50% of the equipment costs of competitive processes is required and operating costs are no higher, with equal or better product.

Furnace, oven, dryer— Bristol controls them all

Whatever your industrial heating application, you can find a Bristol instrument or instrument system to provide precision indication, recording or automatic control. The following instruments, in almost innumerable variations, are typical of the truly complete Bristol instrument line.



Bristol's Dynamaster* Potentiometer Pyrometers come in round or strip chart models, provide electronic recording, indication, and electric or pneumatic control, including high-low contact, proportional, time-program and many combinations. The outstanding instrument for maximum precision.

Bristol Millivoltmeter Pyrometers. Both indicating and controlling models available. Controlling models utilize unique Bristol Free-Vane* principle that completely eliminates relay "chatter" or "flutter." High-low contact and proportional models available in a wide variety of combinations.

Bristol Miniature Instruments – Bristol is the only company offering a complete line of instruments in both miniature *and* full-size for all recording, indicating and control applications, both electronic and pneumatic. True plug-in construction. Ideal where panel space must be conserved.

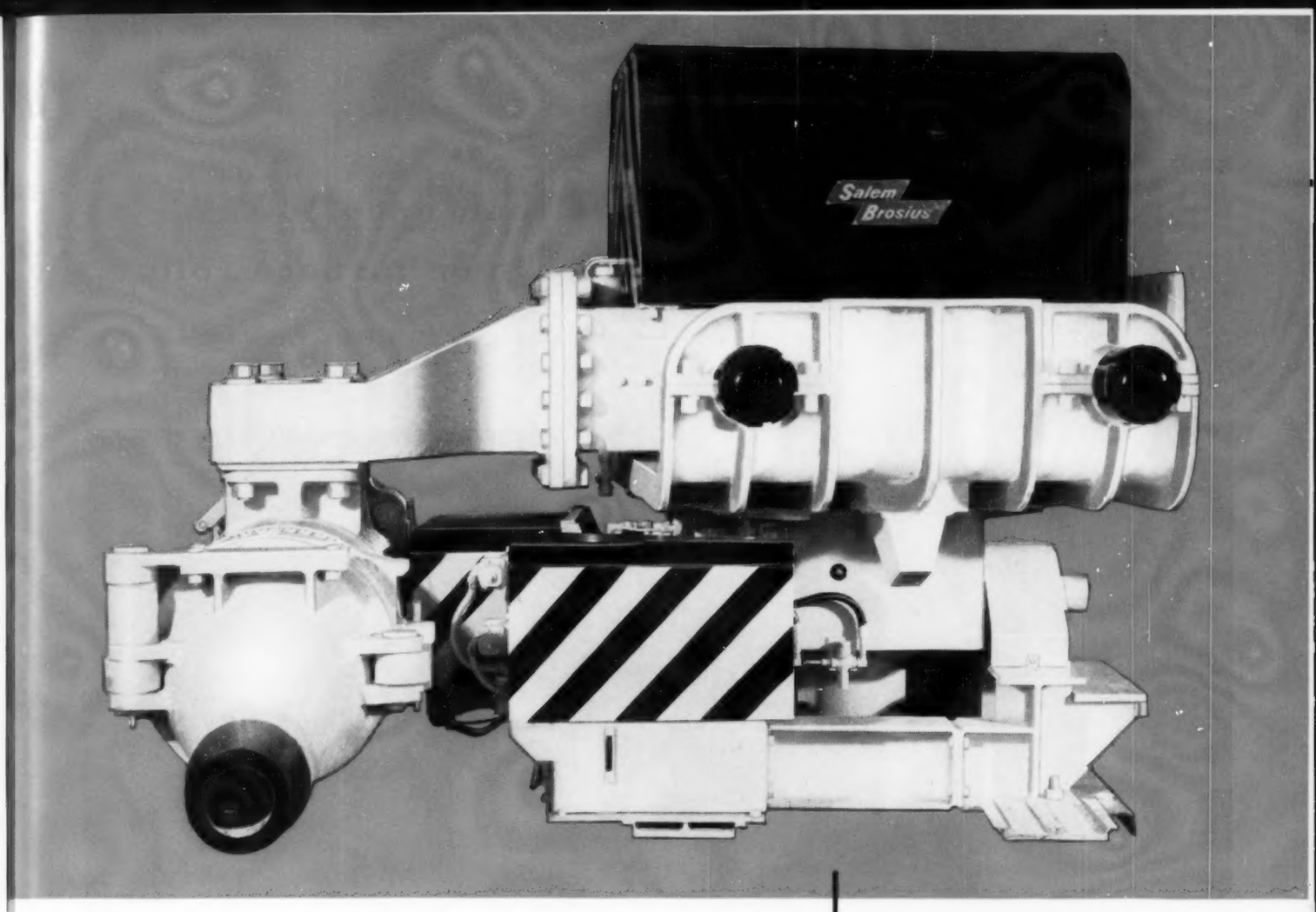
*T. M. REG. U. S. PAT. OFF.

Write for complete data on Bristol instruments for your furnace, oven, dryer or kiln. And remember, Bristol makes a complete line of thermocouples and pyrometric accessories. The Bristol Company, 123 Bristol Road, Waterbury 20, Conn.

8.26

BRISTOL *TRAIL-BLAZERS IN PROCESS AUTOMATION*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS



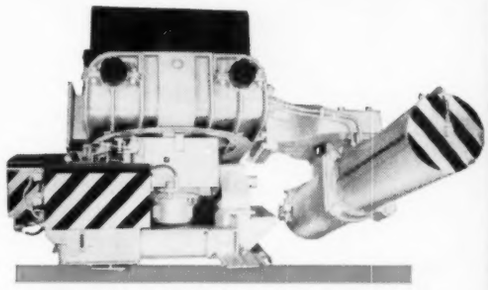
New . . .

All-hydraulic clay gun meets modern blast furnace needs

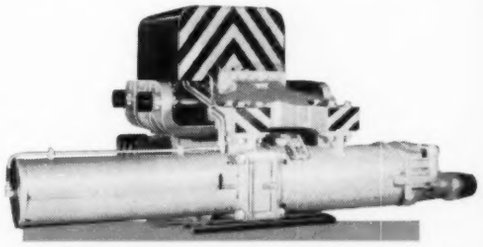
After years of design and testing, Salem-Brosius now offers the iron-making industry a completely new hydraulic clay gun compatible to the trend toward greater capacity and higher pressure furnaces. The new gun embodies the following completely unique set of features:

- Standard nozzle pressures up to 800 psi (higher nozzle pressures optional)
- Optional 12 or 15 cu ft clay barrel capacity
- Positive gun lock in tap hole with no latches or connections to the furnace
- Positive, accurate gun path travel
- Automatic or single stage cycling
- Push-button control
- Pedestal base with no mountings on furnace
- No relative motion between clay barrel and base
- No gears, tracks, pinions, or racks to wear
- Suitable for either right or left hand operation
- Removable, renewable liners in clay barrel
- All motions hydraulically actuated and electrically controlled
- Non-inflammable hydraulic fluid eliminates fire hazards

For further information concerning this gun, write to Salem-Brosius.



Barrel in tilted position. Travel path is fast and accurate—nozzle locks into tap hole.



Construction is rugged and simple for long-life and easy maintenance.

SALEM-BROSIUS, INC.

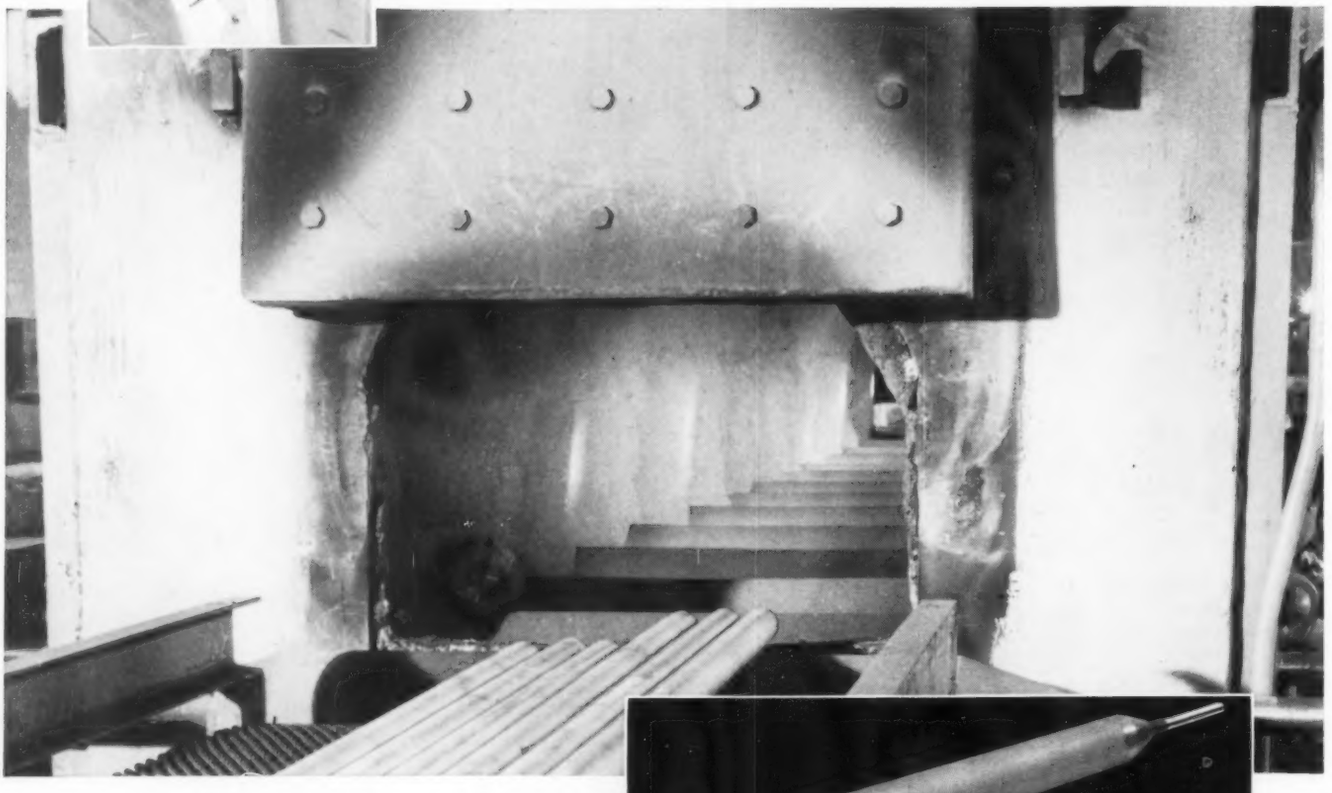
CARNEGIE, PENNSYLVANIA

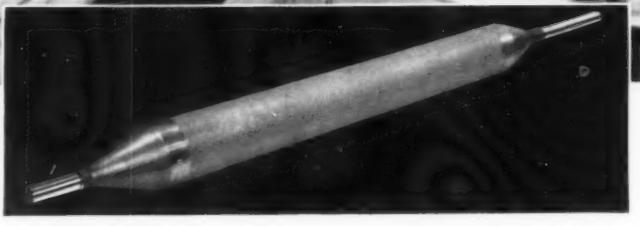
In Canada: Salem Engineering Limited • 1525 Bloor Street West, Toronto 9, Ontario

SPECIAL MECHANICAL EQUIPMENT • INDUSTRIAL HEATING FURNACES • MATERIALS HANDLING EQUIPMENT

"We more than doubled the expected life of our furnace rolls"

Says Mr. B. B. Burd, Chief Metallurgist
Damascus Tube Co., Greenville, Pa.





Damascus solution-anneals stainless steel welded tubing.

"When we installed Thermalloy* cast furnace rolls, we estimated the service life on the basis of operating temperature of 1950° to 2150° F.

After more than double the expected life, our Thermalloy rolls show no sign of wear and are still operating at peak efficiency!

"I feel the chief reason for this successful service is the careful selection of alloys and the design of the furnace rolls.

"We also employ a maintenance program to further extend the life of the rolls. At the advice of Electro-Alloys, we never completely shut down the furnace. On week ends we maintain the temperature at 1400° F. and keep the rolls turning at idling speed. This reduces the temperature gradient and offsets distortion possible when the rolls are not turning."

Whatever *your* heat-treat problems, Electro-Alloys has the experience necessary to help you solve them. Call your representative — or write Electro-Alloys Division, 9068 Taylor Street, Elyria, Ohio.

*Reg. U. S. Pat. Off.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION Elyria, Ohio

patent reviews

By MELVIN NORD, Patent Attorney, Detroit, Mich.

Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents . . . . patents reviewed cover period March 11, 1958 through April 1, 1958.

OXYGEN CONVERTER VESSEL

△ U. S. 2,826,405, issued March 11, 1958, to Harry L. McFeaters, assigned to Pennsylvania Engineering Corp., describes a top blow oxygen converter vessel.

The principal novel feature relates to the provision of a joint between separate sections of the converter, which will withstand the molten pour, molten metal spatter from the bottom portion and the scarifying, agitated flow of gases, fumes and flame luring the blowing operation.

Figure 1 shows how the upper part or sector may be removed after it has been raised off the lower sector and after securing bolts and alining pins have been removed, but while trunnion bearing bolts are still in position as to the lower sector.

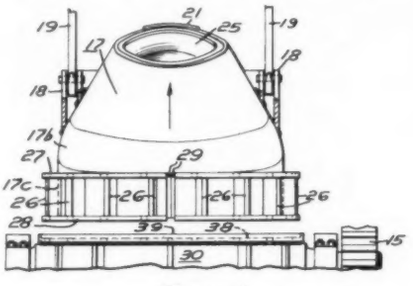


Figure 1

Figure 2 shows the position of the bottom sector after it has been rotated about 180 degrees and illustrates how it may be lifted clear of the bearings for transportation to a repair station; the full lines show the bottom sector in its normal or lower position and the dot and dash lines show it in its upper 180-degree position. Such dot and dash lines also show how the bearing means and the gear for the trunnions may be removed.

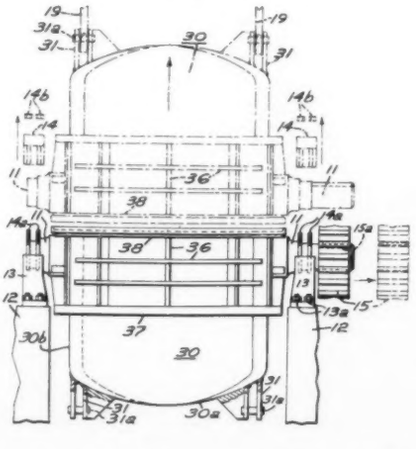


Figure 2

METHOD OF SINTERING ORE FINES

△ U. S. 2,826,487, issued March 11, 1958, to William L. Davis, Jr., assigned to United States Steel Corp., describes an improved method of sintering iron ore fines, which eliminates the need for adding solid fuel to iron ore and the attendant handling and mixing problems.

The apparatus consists of a reactor A and a sintering machine B (Figure 3). The reactor is of a type in which solid particles can be maintained as a fluidized bed resembling a boiling liquid by introduction of gas from beneath. Iron ore fines are introduced to the top of the reactor and reducing gas to the bottom and the temperature is maintained at 1100 to 1400 F. A reduced product, predominantly ferrous oxide, discharges from the reactor and is fed to the sintering machine. There it forms a bed which is ignited and burned in the usual way. The sinter discharges from the opposite end of the machine and is ready for further treatment, as in a blast furnace.

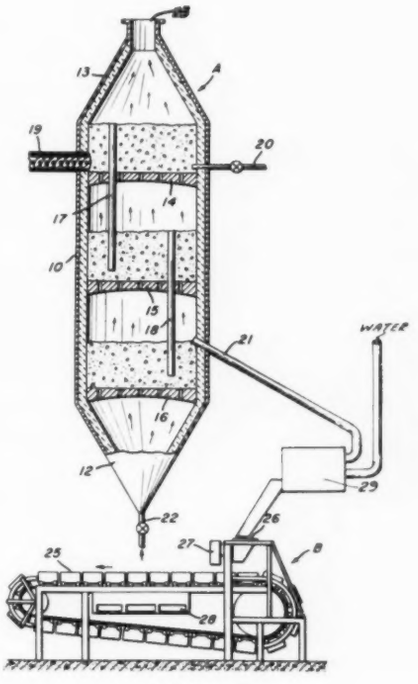


Figure 3

In more detail the reactor A illustrated is a heat-insulated vessel which includes a main cylindrical portion 10 and bottom and top conical portions 12 and 13. The vessel contains upper, central and lower fixed perforated plates 14, 15 and 16 which divide it into compartments. The upper and central plates 14 and 15 carry standpipes 17 and 18 respectively. An ore

feeder 19 (for example a screw conveyor) and an air inlet 20 lead to the uppermost compartment. A product discharge pipe 21 leads from the compartment above the lower plate 16. The bottom and top conical portions 12 and 13 have a gas inlet and discharge 22 and 23 respectively.

Preheated reducing gas is introduced to the lowermost compartment beneath the lower plate 16 via the inlet 22. The reducing constituent of this gas is a mixture of hydrogen and carbon monoxide obtained by reforming natural gas. To assure that the ore is reduced only to FeO and not to metallic iron, the reducing gas can be diluted with CO_2 and H_2O to furnish CO_2/CO and H_2O/H_2 ratios that are above the equilibrium ratios effective for reducing the material to metallic iron. Iron ore fines are introduced to the uppermost compartment via the feeder 19. The ore can be as coarse as minus $\frac{3}{8}$ in., and can be any of the commonly occurring oxide ores. The gas passes upwardly through the successive perforated plates and the ore downwardly via the standpipes 17 and 18.

The ore is preheated in the top bed by heat obtained from burning the gas which reaches this bed from below with air introduced via the inlet 20, and also by the sensible heat in this gas. Actual reduction of the ore takes place in the central bed, where the materials are at a temperature of 1100 to 1400 F. Higher temperatures are objectionable, since they tend to cause sticking, while lower temperatures do not produce sufficiently rapid reaction rates. Process conditions are regulated to reduce the ore to a uniform product, predominantly ferrous oxide. Commonly the ore is 25 to 35 per cent reduced, depending on its initial stage of oxidation. Any greater reduction results in an over-burned sinter of low porosity and reducibility. The product which discharges from the vessel is not pyrophoric.

The sintering machine B illustrated includes a traveling grate 25, a feed spout 26, and igniter 27 and a wind box 28, all of which operate in the usual way. Reduced ore from the reactor A is charged to the grate 25 to form the usual bed, which is ignited by the igniter 27. The wind box 28 draws a downdraft of air through the bed to support oxidation. Under these conditions ferrous oxide reoxidizes to form an excellent porous sinter of superior mechanical strength to ordinary sinter. The grate can be somewhat shorter than usual, since the reaction is more rapid. Only 6 to 12 minutes are required for sintering a 12-in. dry bed. The charge to the bed can be either dry or water tempered (approximately 7 to 10 per cent water added). A water-tempering device is indicated at 29. With a dry bed some sinter is returned to the feed to improve the permeability. With a water tempered bed no sinter need be returned.

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or assignee
2,825,933	3/11/58	Manufacture of slag wool	The Carborundum Co.
2,825,947	3/11/58	Continuous casting of steel	Norman P. Goss
2,826,103	3/11/58	Boring mill table bearing	American Steel Foundries
2,826,406	3/11/58	Snubbed spring group	American Steel Foundries
2,826,494	3/11/58	Production of alloy steels by blowing carbonyls or other gases through molten metal	The Commonwealth Engineering Co. of Ohio
2,826,496	3/11/58	Austenitic, chromium-nickel steel	The Carpenter Steel Co.
2,826,497	3/11/58	Magnesium-containing addition agent	The International Nickel Co., Inc.
2,826,517	3/11/58	Process for phosphatizing steel	Kelite Products, Inc.
2,826,805	3/18/58	Sintering stainless steel alloy	Federal-Mogul Corp.
2,827,182	3/18/58	Coal charging larry for coke ovens	Koppers Co., Inc.
2,827,236	3/18/58	Continuous draft indicator for rolling mills	Jones & Laughlin Steel Corp.
2,827,278	3/18/58	Forge furnace atmosphere control apparatus	Surface Combustion Corp.
2,827,279	3/18/58	Tuyeres provided with coolant passages	American Brake Shoe Co.
2,827,407	3/18/58	Production of powdered steel products	Federal-Mogul Corp.
2,827,424	3/18/58	Coke quenching station	Koppers Co., Inc.
2,827,962	3/25/58	Flying shears	Wean Equipment Corp.
2,828,188 & 2,828,346	3/25/58	Recovery of anthracene	United States Steel Corp.
2,828,202	3/25/58	Titanium tool steel	Sintercast Corp. of America
2,828,516	4/1/58	Ladle for casting metal	Koppers Co., Inc.
2,828,654	4/1/58	Finishing mill for thin sheet metal	Karl F. Ungerer
2,828,852	4/1/58	Roller conveyor for centering objects	United States Steel Corp.
2,828,954	4/1/58	Multiple furnace for heating billets to be forged or extruded	William M. Dickson
2,828,956	4/1/58	Top blowing oxygen nozzle	Union Carbide Corp.
2,829,046	4/1/58	Stainless steel	Quebec Metallurgical Industries Ltd.
2,829,089	4/1/58	Nozzle for coke ovens	Eusebio A. Recchie

METHOD OF PROCESSING GRAIN-ORIENTED SILICON STEEL

△ U. S. 2,826,520, issued March 11, 1958, to Reginald L. Pickett, assigned to United States Steel Corp., describes a method of heating so-called 3 per cent silicon steel slabs prior to hot rolling, cold reducing and heat-treating to produce a grain-oriented structure.

The process consists of soaking slabs of silicon steel containing between 3 and 3.5 per cent silicon at temperatures between about 2225 and 2275 F, for a minimum of about 8 hours prior to hot rolling. These slabs result from conventional "slabbing" or rolling of ingots to an intermediate gage workpiece which may range from 2 or 3 in. thickness to 6 or 7 in. thickness. The steel ordinarily contains a maximum of 0.025 per cent carbon, 0.08 per cent maximum manganese, 0.005 per cent maximum phosphorus, 0.025 per cent maximum sulphur and 0.15 per cent maximum copper in addition to the foregoing silicon content.

It has been found that the foregoing practice substantially completely homogenizes microsegregations of various elements in the steel.

Following soaking the slabs for between 8 and 10 hours at temperatures between 2225 and 2275 F, they are hot rolled as quickly as possible to about 0.08 in. gage strip and coiled. To obtain optimum qualities, such hot rolling must be completed at temperatures in excess of about 1750 F. Following this, the hot-rolled coils are treated

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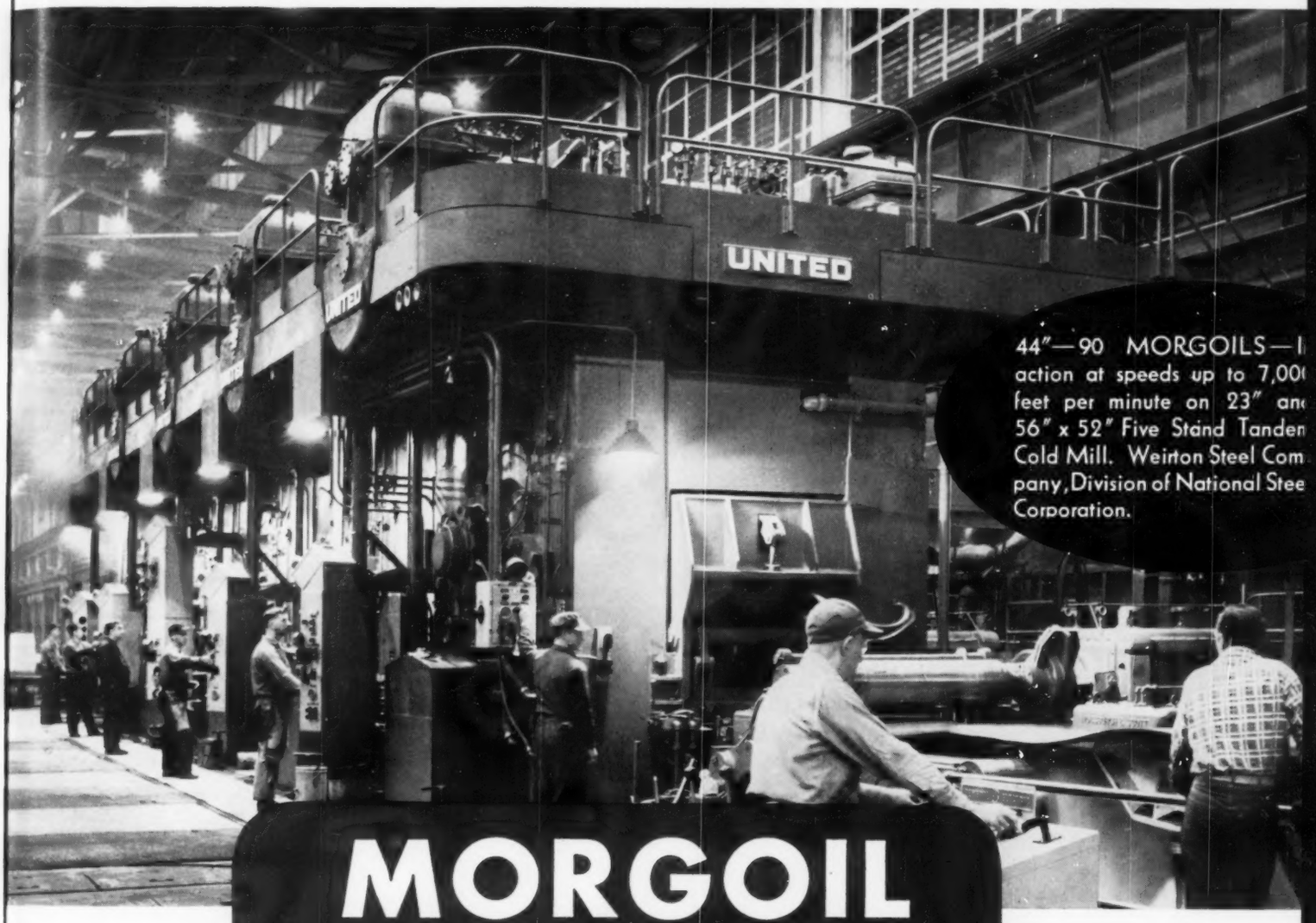

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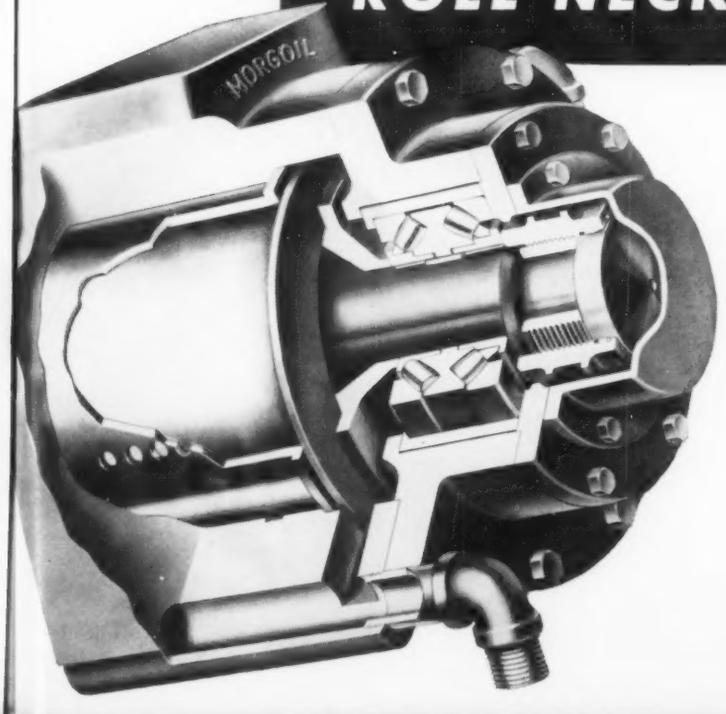

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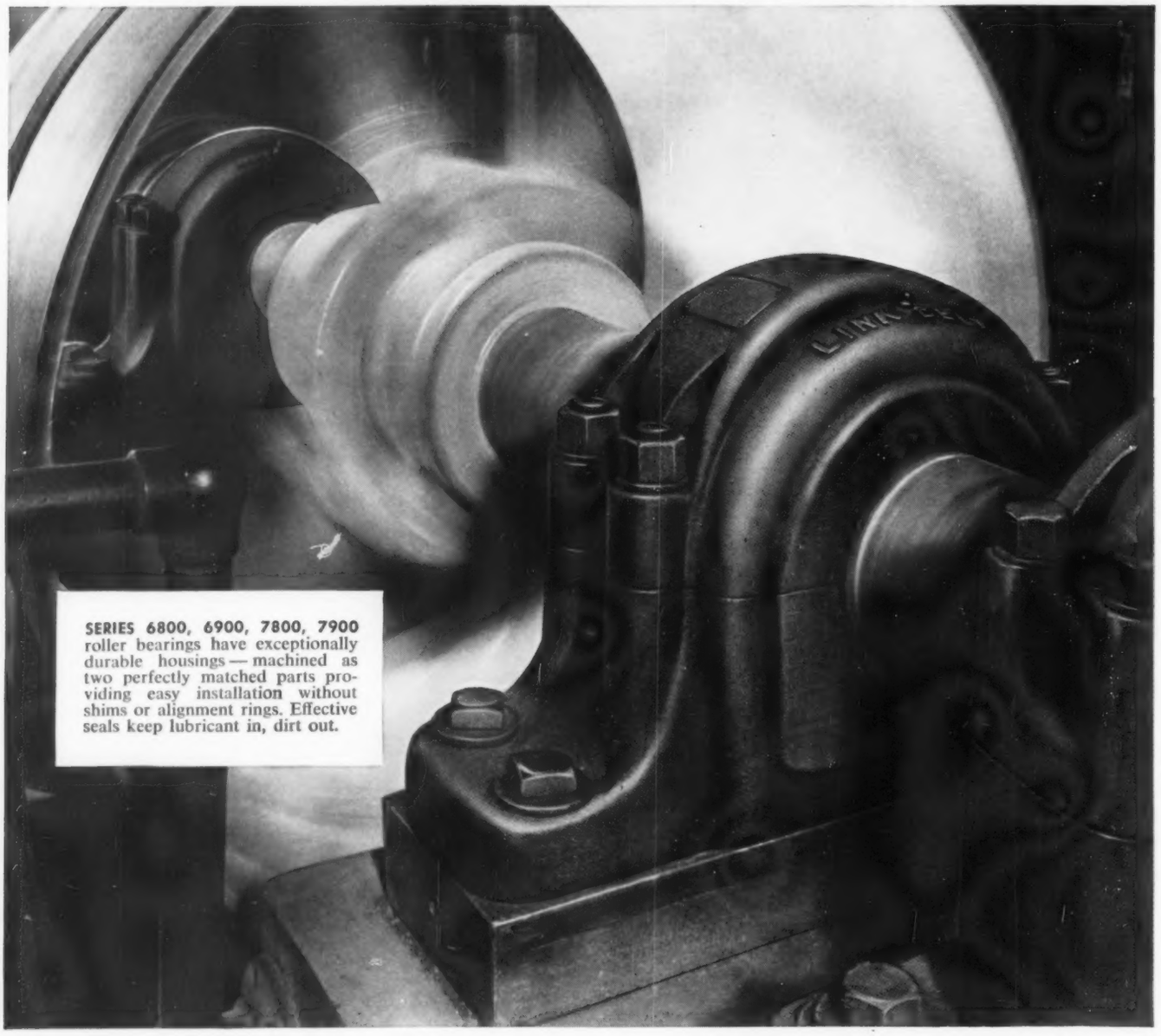

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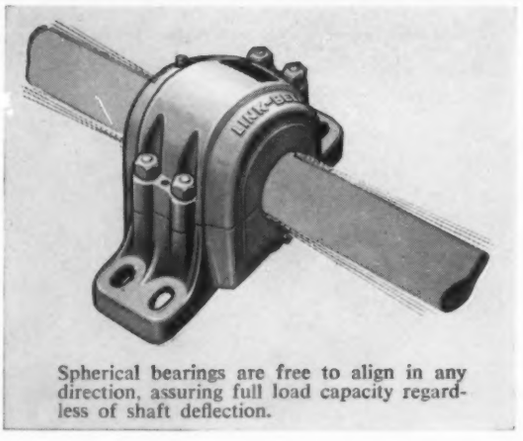

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in accordance with conventional practice to produce a grain-oriented structure therein. That is, the hot-rolled strip is cold reduced to gage in two stages with an intermediate anneal, at about 1700 F. Such anneal is ordinarily a continuous anneal. In the first cold reduction, the strip is reduced from 0.08 to 0.028 in. In the second cold reduction, the strip is reduced from about 0.028 to 0.014 in. After this second cold reduction, the strip is continuously annealed at about 1500 F and is then given a high temperature box anneal at about 2000 F to develop the grain orientation and magnetic properties.

OXYGEN PROCESS FOR MANUFACTURE OF STEEL FROM PIG IRON

△ U. S. 2,826,488, issued March 11, 1958, to James J. Bowden, relates to the manufacture of low phosphorus, low nitrogen steel by oxygen blowing. The object is to increase the extent of contact between the oxygen gas and molten pig iron by increasing the fluidity of the overlying slag. The process employs as a basic, slag-forming material a flux of lime, iron oxide and alumina, premixed and briquetted under pressure.

The patent cites the following example of the method of carrying out the process:

A metallic charge of 93,000 lb, which is made up of 27,000 lb of steel scrap and 66,000 lb of molten pig iron, whose temperature is not less than 2,500 F, is introduced into the refining vessel in that order of addition. The percentage analysis of the pig iron is:

4.0 to 4.5 carbon
0.70 to 1.80 manganese
0.80 to 1.20 silicon
0.200 to 0.500 phosphorus
Iron by difference

The metal charge above is followed directly by the addition of a premixed slag-forming material made up as follows:

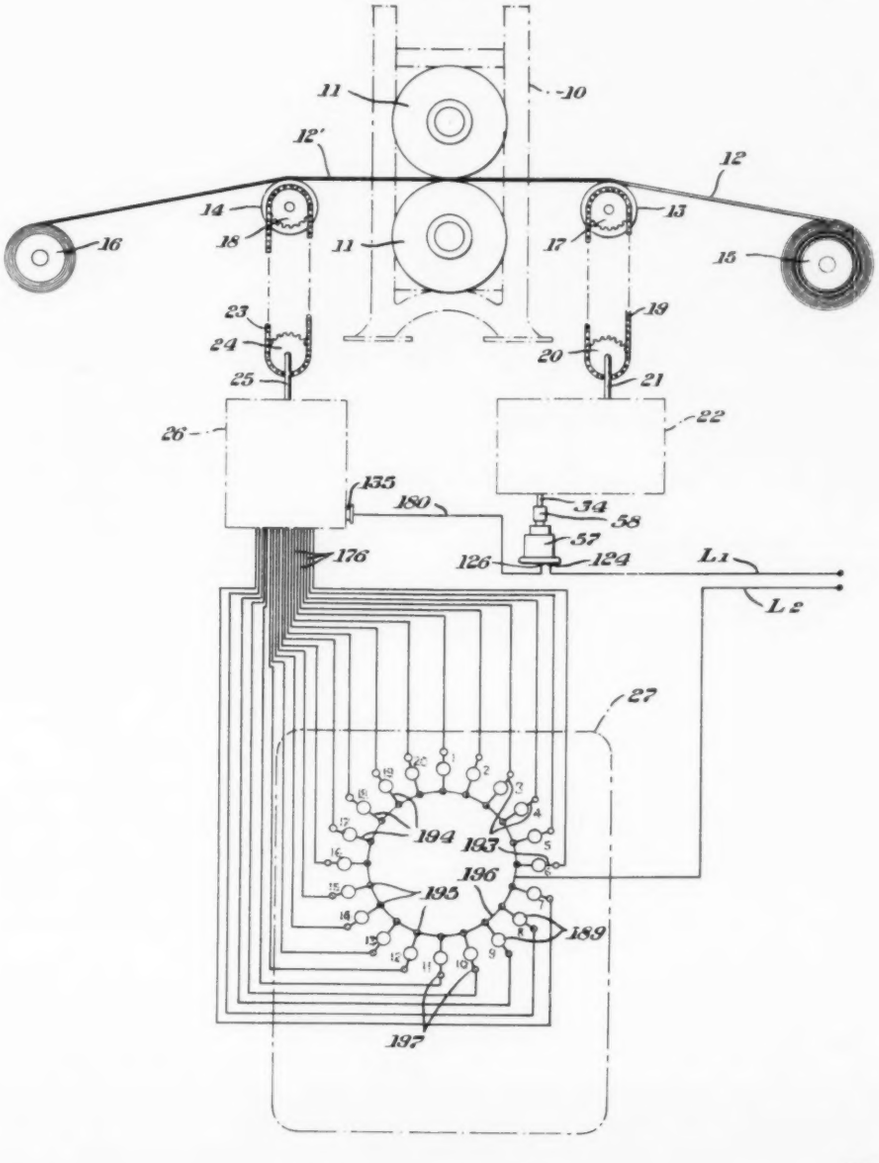
4600 lb of burned lime (CaO)
2000 lb of limestone
900 lb of mill scale
210 lb of aluminum oxide
(as dress, cement, etc.)

Immediately afterward, high purity (99 per cent) oxygen under pressure is introduced through a lance substantially at the surface of the molten mixture. This blowing of high purity oxygen at this point of time, if such is to be successful, must have conditions in the vessel that make it possible for the oxygen to easily and readily reach the surface of the molten metal, where the oxidation takes place. The basic, slag forming material which has been added is intermixed with the molten metal phase. There is an exothermic reaction when oxygen is blown on the metal surface which results from the rapid oxidation of carbon, silicon, iron, manganese and other elements in the charge. The injection of oxygen at the metal surface is continued until the carbon is reduced to the desired final extent by oxidation. The resistance to penetration of the slag has been lowered to such an extent by the addition of the flux, which is high in alumina and also contains an excess of lime, that the oxygen gas has been able to readily reach the surface of the molten metal.

CONTINUOUS DRAFT INDICATOR FOR ROLLING MILLS

△ U. S. 2,827,236, issued March 18, 1958, to Howard H. Shakely and assigned to Jones & Laughlin Steel Corp., describes a mechanical and electrical system to continuously indicate the extent of reduction in thickness of strip made by non-reversing rolling mills, particularly those in which relatively small reductions are effected. The invention is especially useful when applied to cold rolling mills, usually in combination with tension coilers, which operate on lighter gages of strip or which effect

Figure 4



relatively slight reductions in the thickness of the strip as in the case of temper rolling.

In Figure 4 the numeral 10 indicates a nonreversing rolling mill stand having working rolls 11. The gap between the rolls 11 determines the amount of draft applied to a strip 12 being rolled. In the schematic rolling mill illustrated in Figure 4, an entry roll 13 is provided to define that portion of the pass line of strip 12. Similarly, on the delivery side of mill 10, there is provided a delivery roll 14 which defines its portion of the pass line of strip 12 which on the delivery side has a reduced thickness. A payout reel 15 of a conventional nature is at the head of the pass line of strip 12. On the delivery side of mill 10, the reduced thickness of the strip 12′ is continuously wound up on a conventional coiler 16.

The percentage reduction between the thickness of strip 12 on the entry side relative to that represented by the portion 12′ is in exact inverse ratio to the percentage elongation in portion 12′ which takes place by virtue of the draft effected by the rolls 11. If the rolls 13 and 14, respectively, are positioned to deflect the pass line as shown, the surface speeds of those rolls will correspond, respectively, to the linear speed of the entry portion of strip 12 and of the delivery portion 12′ of the strip 12. Insurance of such correspondence can be provided by maintaining smooth surfaces on the rolls 13 and 14. Normally, in cold rolling there will be no roll pickup of foreign material to disturb the correspondence in question. The entry roll 13 and the delivery roll 14 are ground to the same diameter and finish and are periodically checked. In that way, the difference between the respective angular speeds of rotation of the respective rolls 13 and 14 is a direct measure of the percentage elongation in the strip 12 effected by the rolling operation of mill 10, or stated in another way, is a direct measure of the percentage reduction in thickness in the strip 12 effected by mill 10.

The difference between the slower rotational speed of sprocket 20 and the faster rotational speed of sprocket gear 24 remains a direct and accurate measure of the percentage reduction in the thickness of strip 12 effected by the rolls 11.

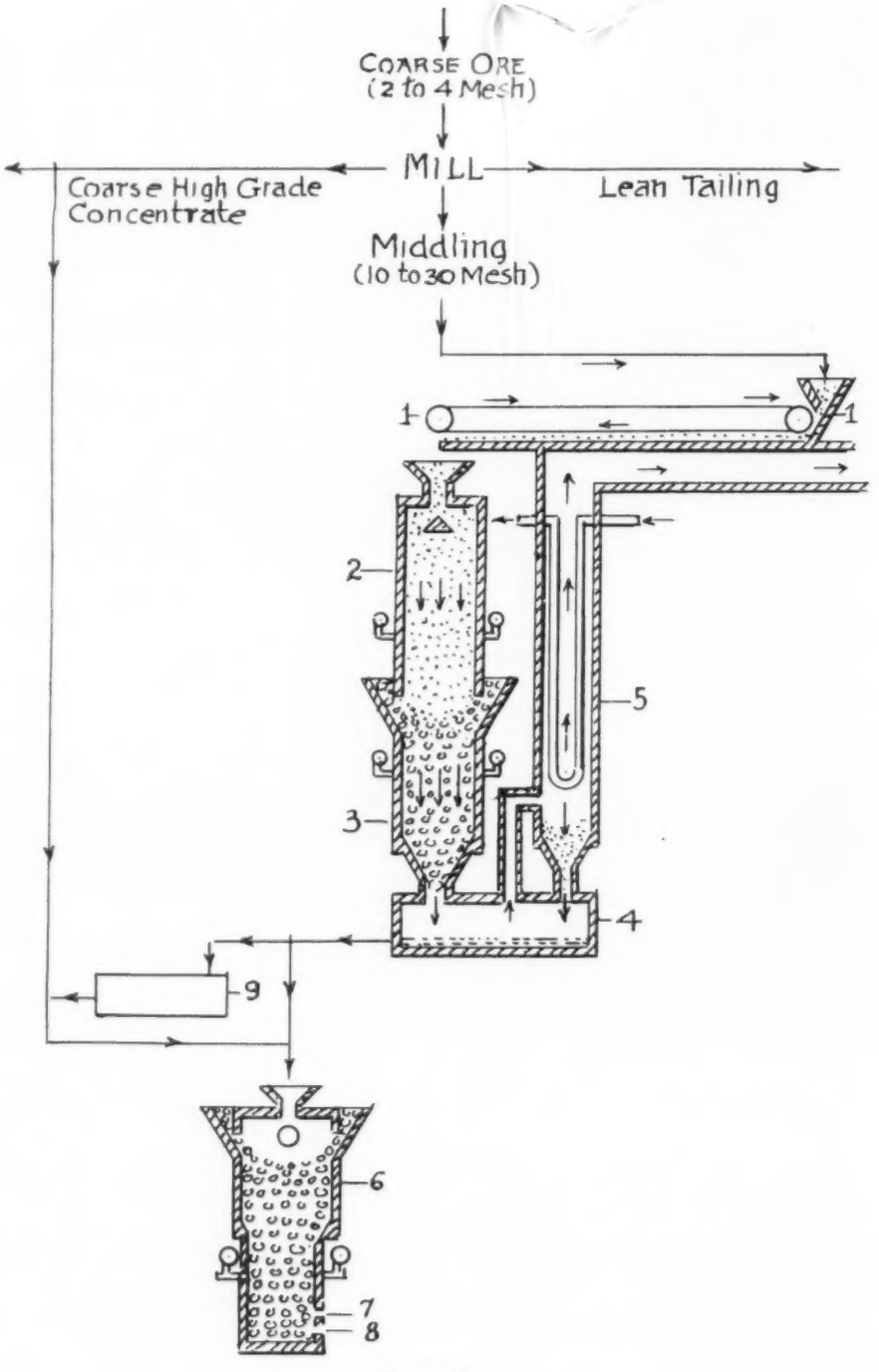


Figure 5

CONCENTRATION OF LOW GRADE ORES

△ U. S. 2,829,043, issued April 1, 1958, to William E. Greenawalt, describes a process of concentrating low grade iron ores.

As shown in Figure 5, the mine ore is coarsely ground to the desired size, usually between 1 and 4 mesh, and subjected to any of the usual methods of mill concentration to produce a high grade coarse concentrate, a lean tailing, and a medium grade middling. The coarse ore concentrate may be smelted direct in a blast furnace in the usual way, without sintering or further treatment of any kind. The tailing is wasted. The middling, which will vary in amount and quality according to the ore, is ground fine enough to be melted in its descent through a shower shaft melting furnace, usually between 10 and 30 mesh. The finely ground middling, usually wet, is dried in the drier 1 and showered through the highly heated atmosphere of a

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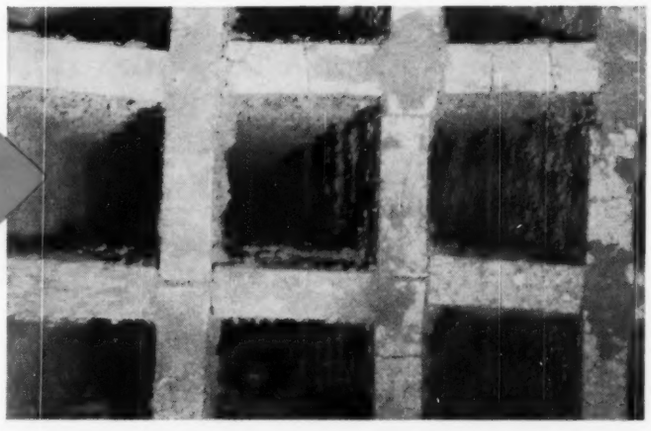

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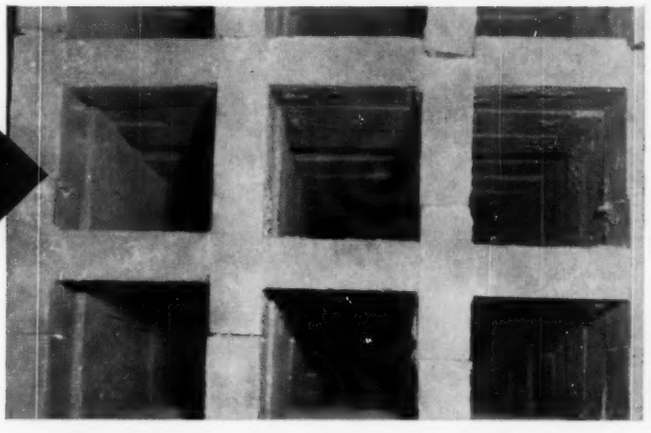

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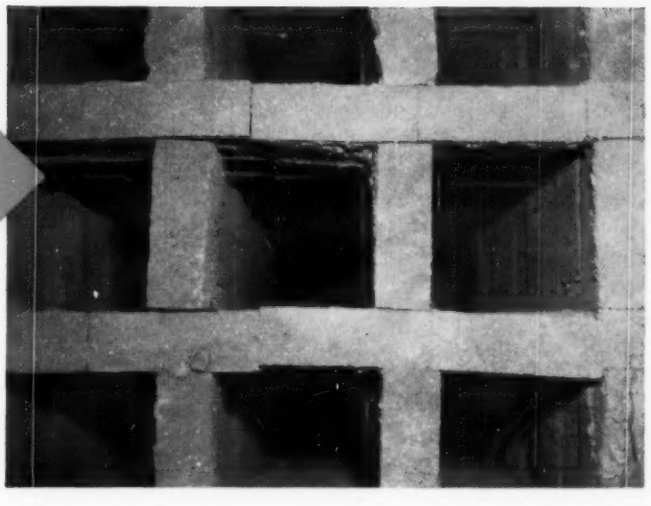

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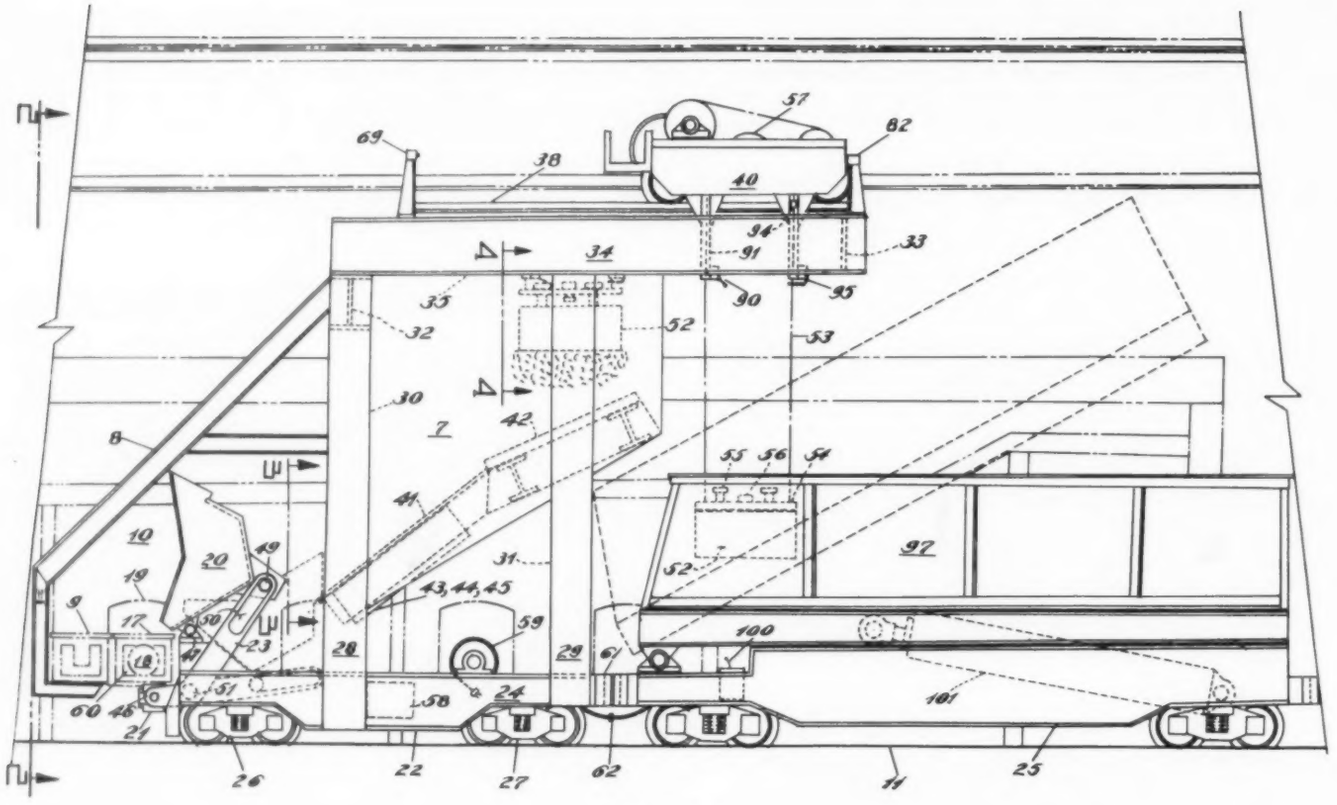


Figure 6

melting furnace 2 in the upper part of a vertical shaft, and flows through a coalescing chamber 3 in the lower part of the vertical shaft, filled with coarse solid material, to coalesce the molten dust of the middling into liquid form. The mixture of molten middling and melting furnace gas, freed or partly freed from dust, flows into the gas separating chamber 4, where the melting furnace gas is separated from the unreduced middling, and where a small amount of dust, if any, is settled out and separated from the melting furnace gas. The melting furnace gas then flows through the heat exchanger 5 where fresh air is heated to be used anywhere in the process. The dust, if any, which settles out in the heat exchanger is returned to the gas separating chamber, where it is fused and mixed with the molten middling. The hot waste gas issuing from the heat exchanger is delivered to the drier 1, to dry fresh middling.

The unreduced molten middling, freed from dust and separated from the melting furnace gas, then flows through a highly heated column of carbon in the smelting furnace 6 where the iron in the unreduced middling is converted into pig iron and the impurities are slagged. The slag flows out through the slag hole 7, and the pig iron through the tap hole 8.

OPEN HEARTH FURNACE LOADING APPARATUS

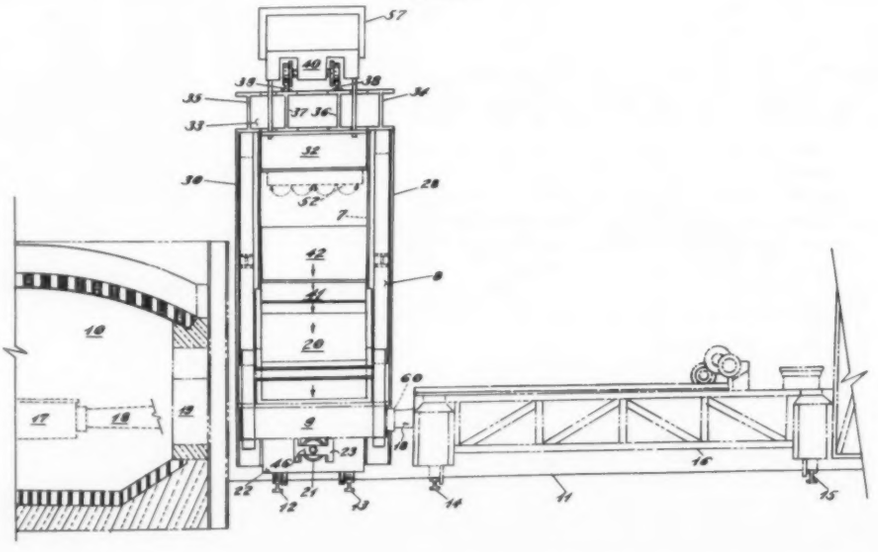
△ U. S. 2,828,874, issued April 1, 1958, to Albert Calderon, assigned to Industrial Automation, Inc., relates to the loading apparatus which receives material from delivery means in front of the furnace and which feeds into a charging container which is repeatedly filled with and cooled by said material. The container is repeatedly emptied into the open hearth furnace by means of a conventional charging machine.

The principal object of the invention is to increase production of steel by providing an apparatus which greatly reduces the length of the charging cycle.

As shown in Figures 6 and 7, the loading apparatus 22 and scrap vehicle 25 run on rails 12 and 13 which extend along the whole front of the battery of furnaces and to the stockyard.

In operation, assuming that it is

Figure 7



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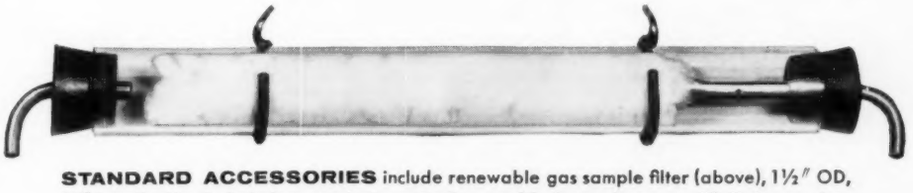

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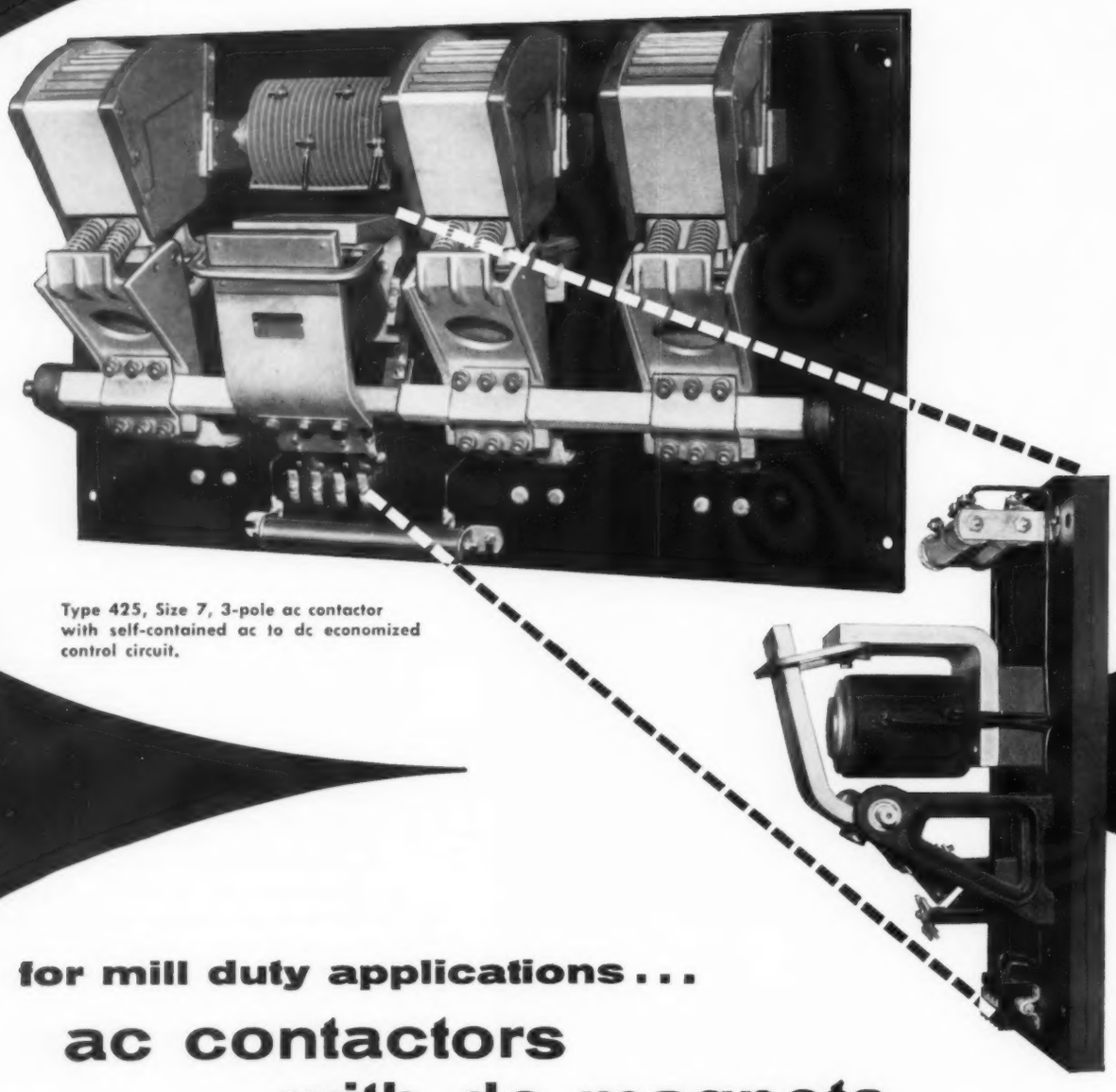

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desired to charge furnace 10 with magnetic material, the operator of charging machine 16 locks peel 18 in socket 60 of container 17, moves loading apparatus 22 to furnace 10 and locates the center of container 17 with the center of charging door 19 through which charging will start. Scrap vehicle 25, which is brought to the floor by means of the conventional locomotive, is coupled to loading apparatus 22 by means of coupling 61. The second helper of furnace 10, whose main duty is to open and close the furnace doors during charging, connects extension cord 62 of vehicle 25 to apparatus 22, to acquire power to operate tilting means of vehicle 25, next connects the control cabinet of apparatus 22 to power source by means of a reel and cord and signals to the operator of charging machine 16 who begins with the operation of tilting bucket 20 to fill container 17 whose contents he empties into furnace 10.

REDUCTION OF IRON ORE IN A KILN

△ U. S. 2,829,042, issued April 1, 1958, to Olav Moklebust, assigned to National Lead Co., describes a process for the reduction of ores in a rotary kiln. Accurate control of temperature conditions is provided, thus preventing "ringing" or sintering of the ore and reduction products in massive form on the walls of the kiln.

In Figures 8 and 9 the rotating kiln body is represented generally by A. At the feed end housing B is located a feed screw conveyor 10. Housing B is also equipped with stack 12 having a damper 14 located in it. The stack 12 is connected to fan 13, which assists in controlling the draft within the kiln. The other end, i.e., the discharge end of the kiln, is in close proximity to combustion chamber C which is equipped with burner 16 for the introduction and partial combustion of fuel, such as oil or gas. There is also provided discharge means 18 for removal of furnace products.

A number of tubes 20 are positioned along the length of the kiln body and extend generally to the horizontal axis. Each tube is provided with valve 22 which can be opened or closed independently of the others, to permit entrance of the calculated amount of air or oxygen containing gas through the tube.

A mixture of gas and air is introduced into the burner and ignited under conditions of complete oxidation. The heat values so produced are employed to heat the combustion chamber and part of the rotary kiln initially. When the area of this kiln immediately adjacent to the combustion chamber reaches 1940 F, the amount of gas introduced into the burner is increased, thereby yielding a partially combusted mixture. This combustible gaseous mixture is then transferred to a more forward position in the rotary kiln generally represented at point I. The valve 22 of air tube 20 which is positioned at this point is then adjusted so as to permit the introduction of air and thus effect the combustion of enough of the combustible mixture so as to result in liberation of heat values sufficient to effect the desired reaction and maintain the temperature of the kiln at that point as desired. The process of progressively transferring heated combustible gaseous mixture to a more forward point in the kiln and selectively liberating the required heat values so as to effect the desired chemical reaction and at the same time establish the desired temperature condition is continued by employing the air tubes along the length of the kiln as described and by also regulating the draft by means of the valve 14 and fan 13. At the point generally identified as II, which point is near the feed end of the kiln, the combustible gases are completely burned and the exhaust gases passing out of the flue show a composition of substantially complete combustion. By this is meant that only a fraction of a per cent of carbon monoxide can be detected in the flue gas.

It is thus possible to maintain temperature in every part of the kiln with an accuracy of ± 5 F.

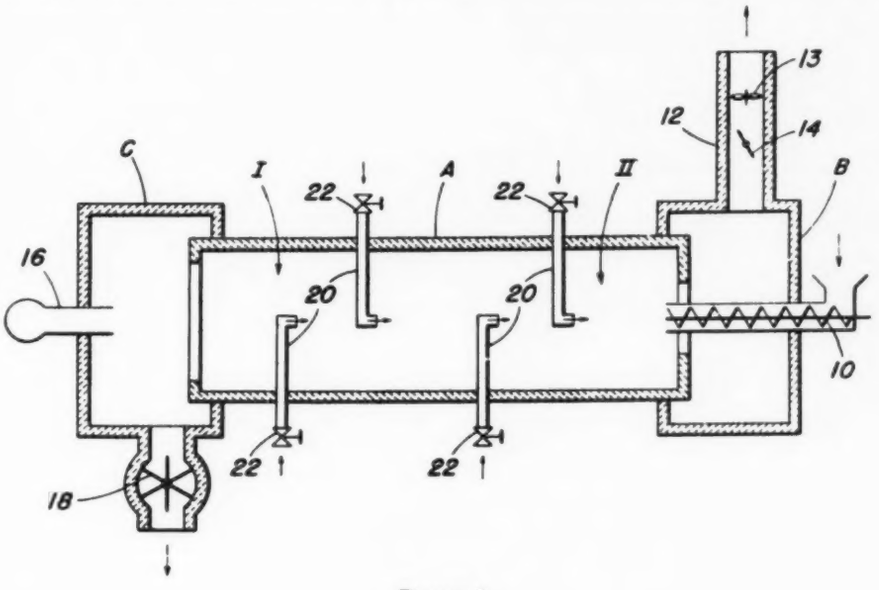
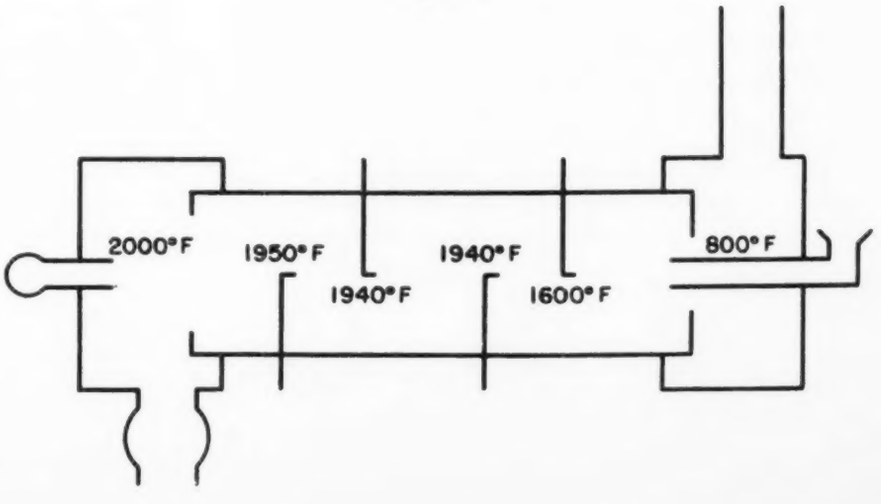


Figure 8

Figure 9



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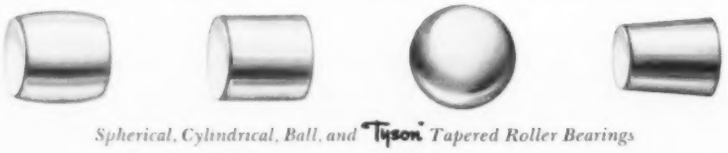

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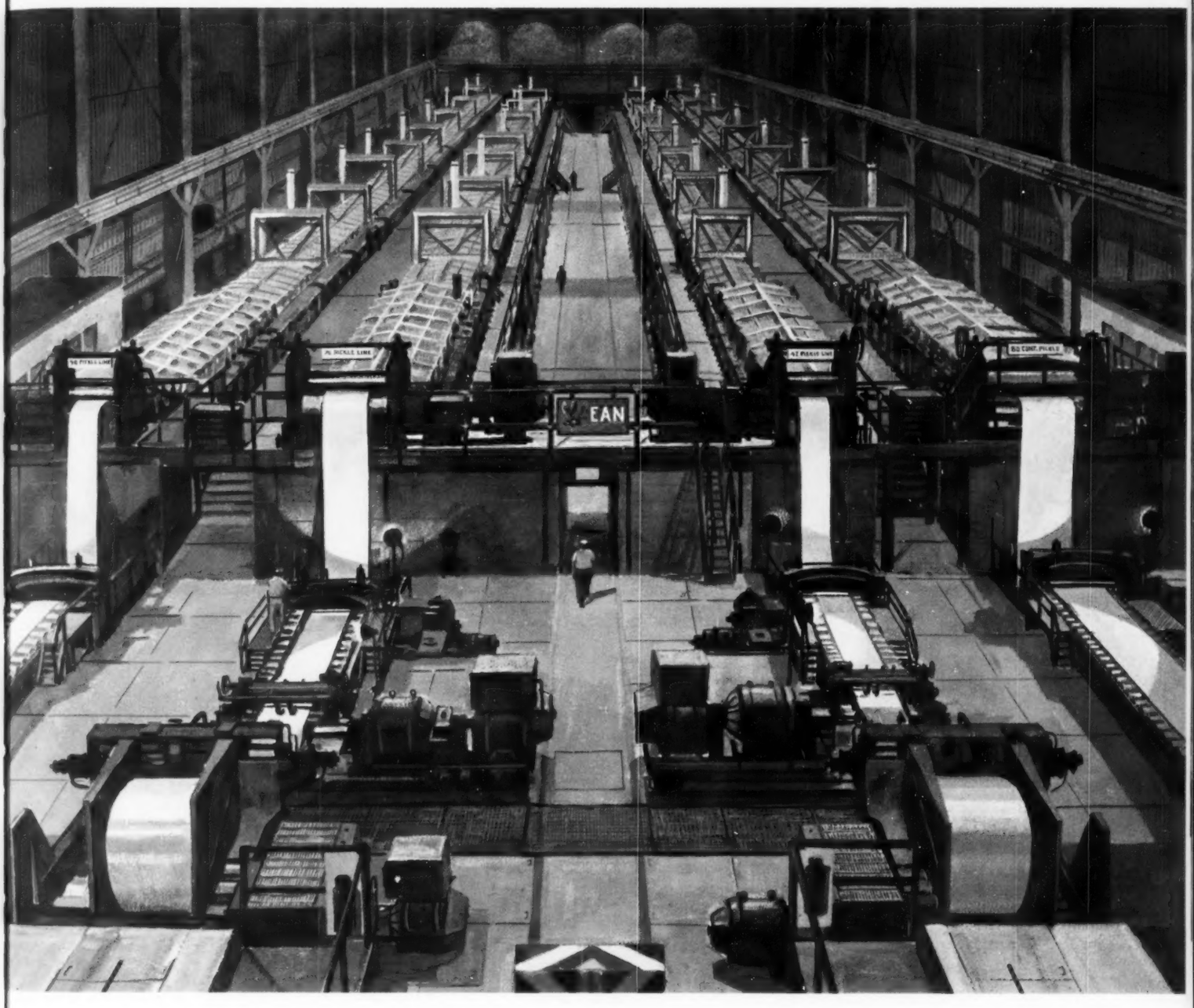

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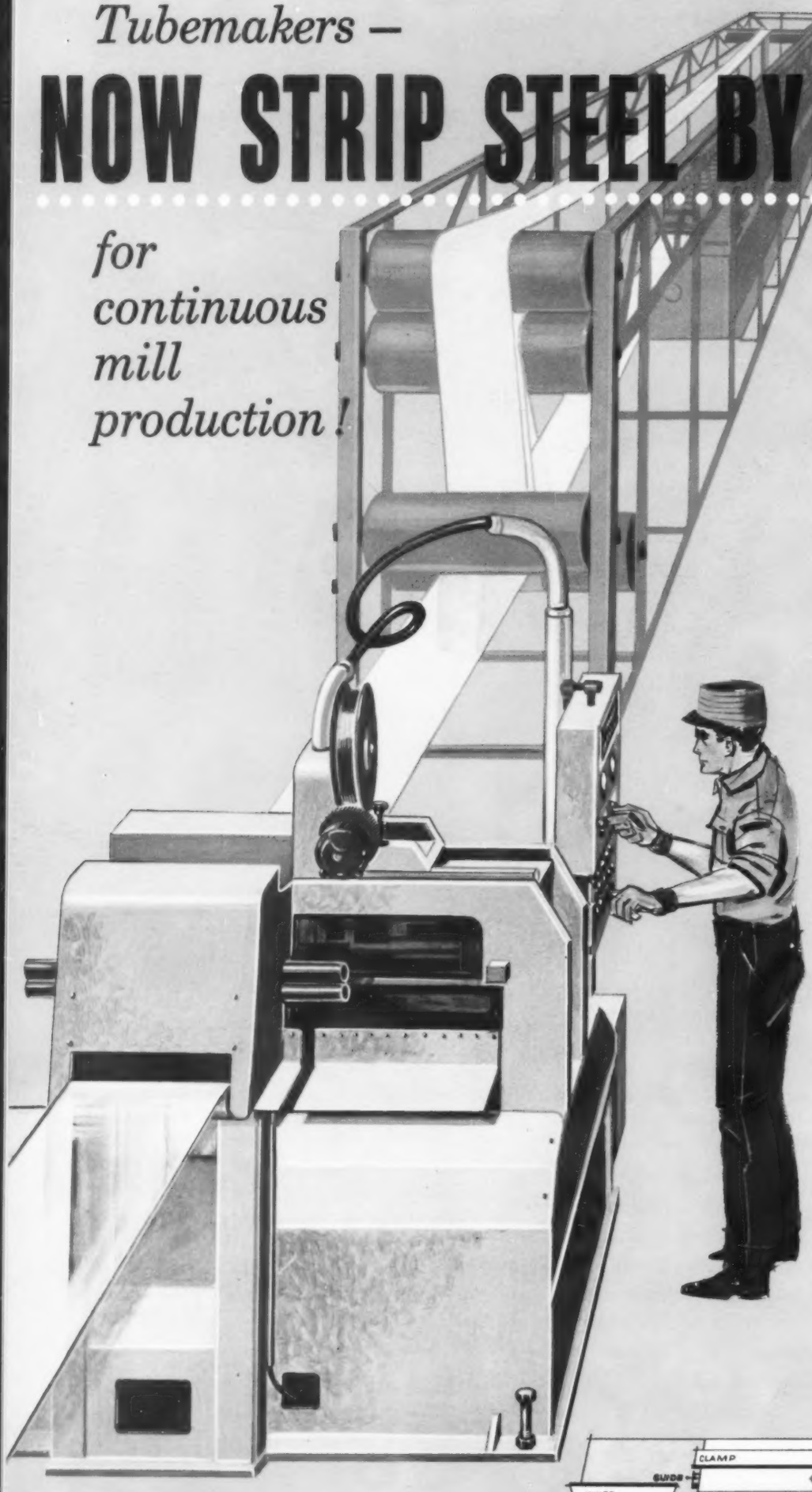
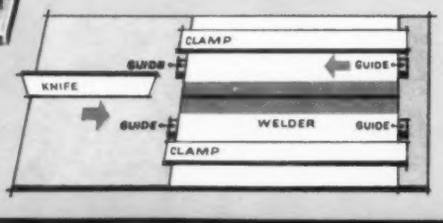


The "MPM SHEAR WELDER" is "a natural" for increasing output and reducing coil end scrap loss.

Perfect welds are a result of positive guiding and clamping, right at the weld area. *(See diagram below.)* Both shearing and welding are done at the same station.

The "MPM" is the fastest, most accurate and compact machine of its kind, that's why tubing manufacturers prefer them over any other type. They are available in a complete range of sizes for any tube mill application. Other types are available for joining strip or sheets of any metal.

Metal Processing Machine Co.
Subsidiary of The McKay Machine Co.
YOUNGSTOWN, OHIO



McK
MPM

10082

PROOF: Shaw-Box can build cranes to your specs (or AISE)

Every steel mill has its own special materials handling problems. Problems which could be handled by standard crane designs 30 years ago now demand cranes built to specifications unique to a single mill.

These ten leading steel companies developed their own crane specifications (or chose modern AISE standards.) Each awarded the job of constructing the crane to Shaw-Box.

REASON: Shaw-Box can produce *any* type of crane of *any* capacity. We are not bound by traditional concepts of design. Usually, we can offer better delivery. Control of Shaw-Box Cranes is a miracle of precision and speed.

When your company next prepares specifications for a crane — of any type — make sure they are sent to Shaw-Box.

58K-1

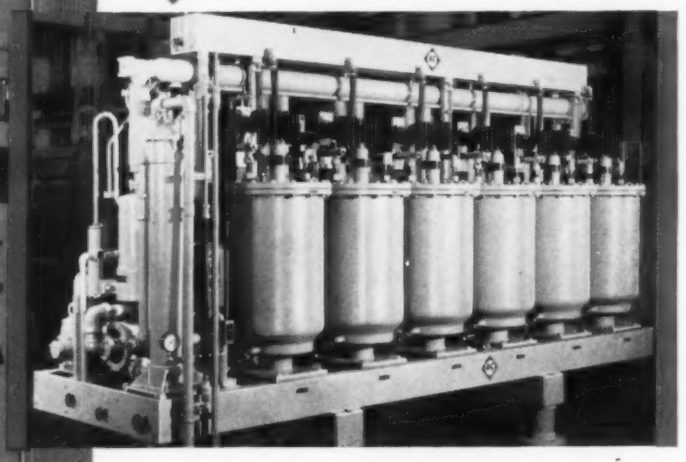
"Shaw-Box"® CRANES

MANNING, MAXWELL & MOORE, INC.
SHAW-BOX CRANE & HOIST DIVISION
388 West Broadway • Muskegon, Michigan

Builders of "SHAW-BOX" and 'LOAD LIFTER' Cranes, 'BUDGIT' and 'LOAD LIFTER' Hoists and other lifting specialties. Other Divisions produce 'ASHCROFT' Gauges, 'HANCOCK' Valves, 'CONSOLIDATED' Safety and Relief Valves, 'AMERICAN' and 'AMERICAN-MICROSEN' Industrial Instruments.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Avenue Road, Galt, Ontario.*

Open pumped tube unit permits easy access for inspection. Easy to recondition in field.



Enclosed sealed tube unit conserves space, cuts installation costs, eliminates need for vacuum pumping system.

ALLIS-CHALMERS

Mercury Arc Rectifiers

Pumped or Sealed? Open or Enclosed?

Here's how Allis-Chalmers can help you choose a rectifier for your job—

BOTH sealed and pump-evacuated tube rectifiers offer distinct advantages, depending upon the application. Whether your rectifier should be open or enclosed construction also depends on the application. Since Allis-Chalmers offers you a choice of sealed or pumped tubes in either open or enclosed construction, you get an unbiased recommendation, based on a study of your needs, and not on commercial expediency. And you can be sure of unsurpassed reliability and ease of operation, as proved in hundreds of Allis-Chalmers installations.

Only Allis-Chalmers Excitron Rectifiers give you all these important advantages—

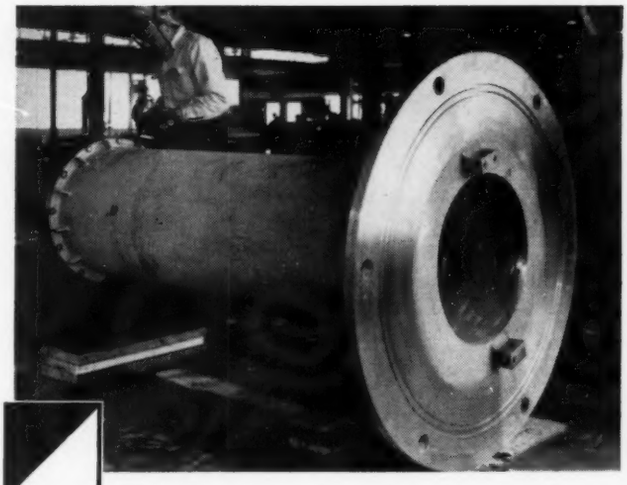
- **Fixed excitation anode** does not contact mercury — is independent of level, turbulence or impurities.
- **Continuous excitation** eliminates need for reignition — pilot arc always present.
- **Grid phase control** located in clean region near anode where ion density is lowest.
- **Internal cooling system** provides high heat transfer with seamless tube coil.
- **Arc-over-free tube** eliminates arc-over danger by insulating entire arc path.
- **Enameled anode seals** provide high strength, trouble-free seal.

For detailed information on mercury arc rectifiers contact your nearest A-C office, or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin, for bulletin 12B8494.

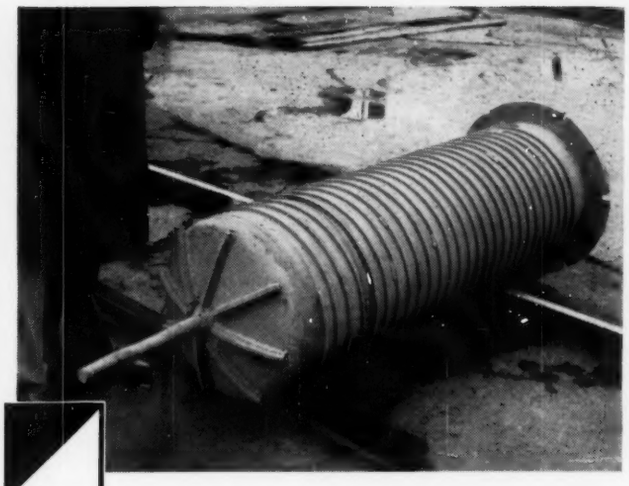
ALLIS-CHALMERS

A-C ALLIS-CHALMERS

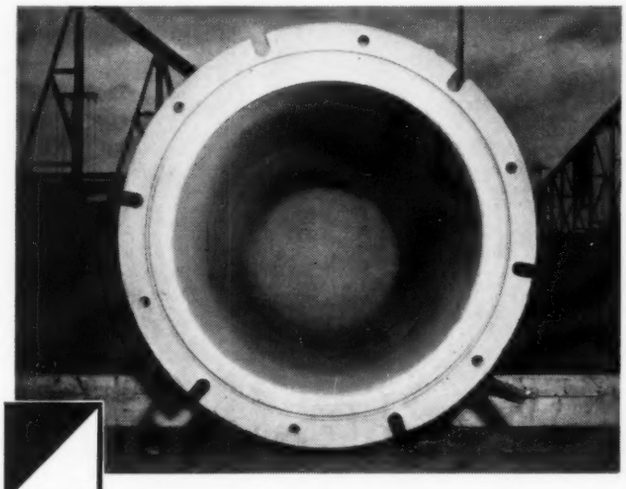
A-5560



23" Diam. Copper Crucible for Vacuum-Melting of Steel, completely fabricated and machined, ready for installation.



Copper Mold with Water-Circulating Ribs.



Copper Mold for Melting Titanium.

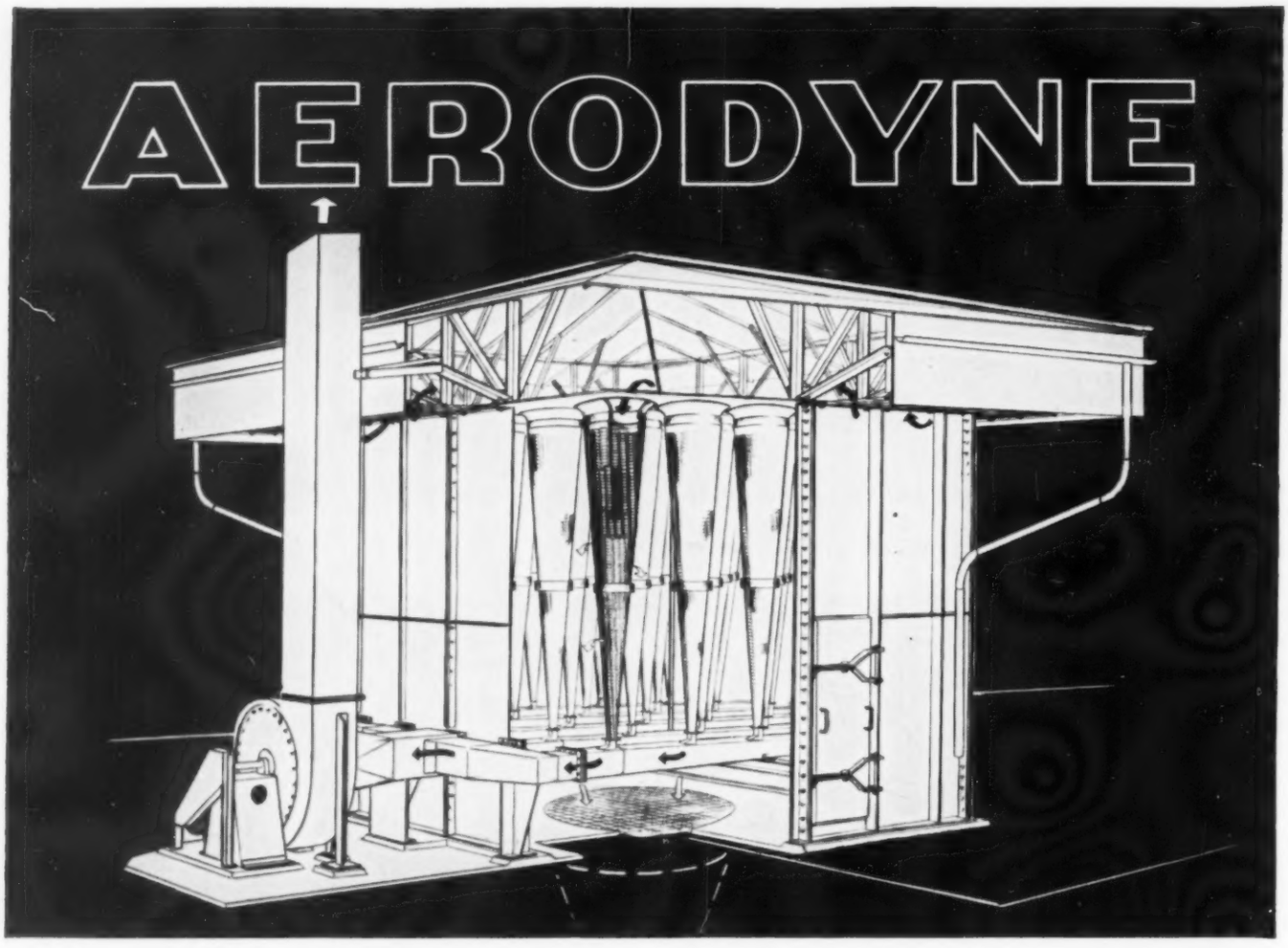
Welding Copper Ribs on Heads for Copper Crucibles.

VACUUM MELTING CRUCIBLES BY WELDCO

FOR TITANIUM AND ALLOY STEELS

We have had extensive experience in making Copper Molds, Jackets, and Furnaces for Vacuum-Melting of Alloys. Progressive producers are boosting their quality sharply by using the Vacuum-Melting Process. Why not investigate the possibilities?

THE YOUNGSTOWN WELDING & ENGINEERING COMPANY
3805 OAKWOOD AVENUE . . . YOUNGSTOWN 9, OHIO



Protects expensive Turbo-Blowers against 'dusty' air

The atmosphere in and around a steel plant can play havoc with turbo-blowers. The air is dusty, carrying large quantities of highly abrasive particles which in a relatively short time cut the blades to pieces.

The Aerodyne is solving this problem . . . as it can in *any* industry faced with dirty air intake to equipment. Installed in a large steel plant, this Aerodyne is extending fan life many times. Formerly, blades were cut down in a few months. Well over a year and a half have now gone by with no sign of appreciable wear.

The story of the Aerodyne in the steel plant is duplicated in many industries. It's a very effective 'dust' remover. We have two descriptive bulletins . . . (1) for Industrial Dust, and (2) for Removal of Fly Ash. In sending for the literature of your choice, we would appreciate it if you would outline your problem. Our reason for asking is that we also make an efficient AIR FILTER, the Econ-O-Roll. It could well be that your requirements call for an air filter rather than a dust collector or perhaps both in series.

THE GREEN
POWER AND PROCESS PLANT EQUIPMENT

FUEL ECONOMIZER CO., INC.
BEACON 3, NEW YORK

Representatives in Principal Cities

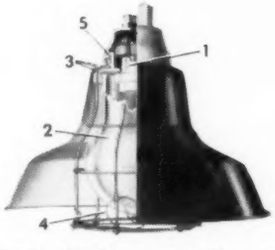
Cuts Re-lamping Costs

IN HALF!

Adapts For Larger Lamp Size

WITHOUT RE-WIRING!

New CROUSE-HINDS VAPORMASTER® Lighting Fixtures



1 *Shock-absorbing receptacle* — takes jolts from any direction. **2** *Pear-shaped globe* — plenty of clearence for lamp. **3** *Vapor-tight seals throughout* — fully gasketed construction. **4** *Globe clamping spring* — flips open for re-lamping — no tools needed. **5** *Aluminum adapter-guard* — 2 sizes fit *all* Condulet bodies.

Here is vapor-tight, shockproof industrial lighting engineered for the greatest possible economy and convenience in both installation and maintenance.

In any indoor or outdoor exposure to moisture, rain, gases, dirt, or corrosive vapors . . . a new standard of operational efficiency is set by the new VaporMaster series. Cleaning and re-lamping is done in half the time, *without tools*. Whenever a demand for a change in lighting intensity develops, a simple change of adapters accommodates the larger lamp — without touching the wiring!

Hundreds of fixture combinations may be assembled from 33 standard components to meet your varying needs. Typical choices:

- *Condulet® bodies* in pendent, ceiling or bracket types and with side hubs.
- Adapters in two forms . . . one for lamps up to 150-watts A23 . . . one for 200- and 300-watts PS30 medium base lamps. Sizes may be changed without disturbing wiring merely by installing adapter for the desired lamp.

ASK FOR CATALOG INFORMATION ON THE VAPORMASTER SERIES TODAY

Just call your Crouse-Hinds distributor . . . or nearest Crouse-Hinds office.

A NATIONWIDE **DISTRIBUTION** exclusively through **ELECTRICAL DISTRIBUTORS**

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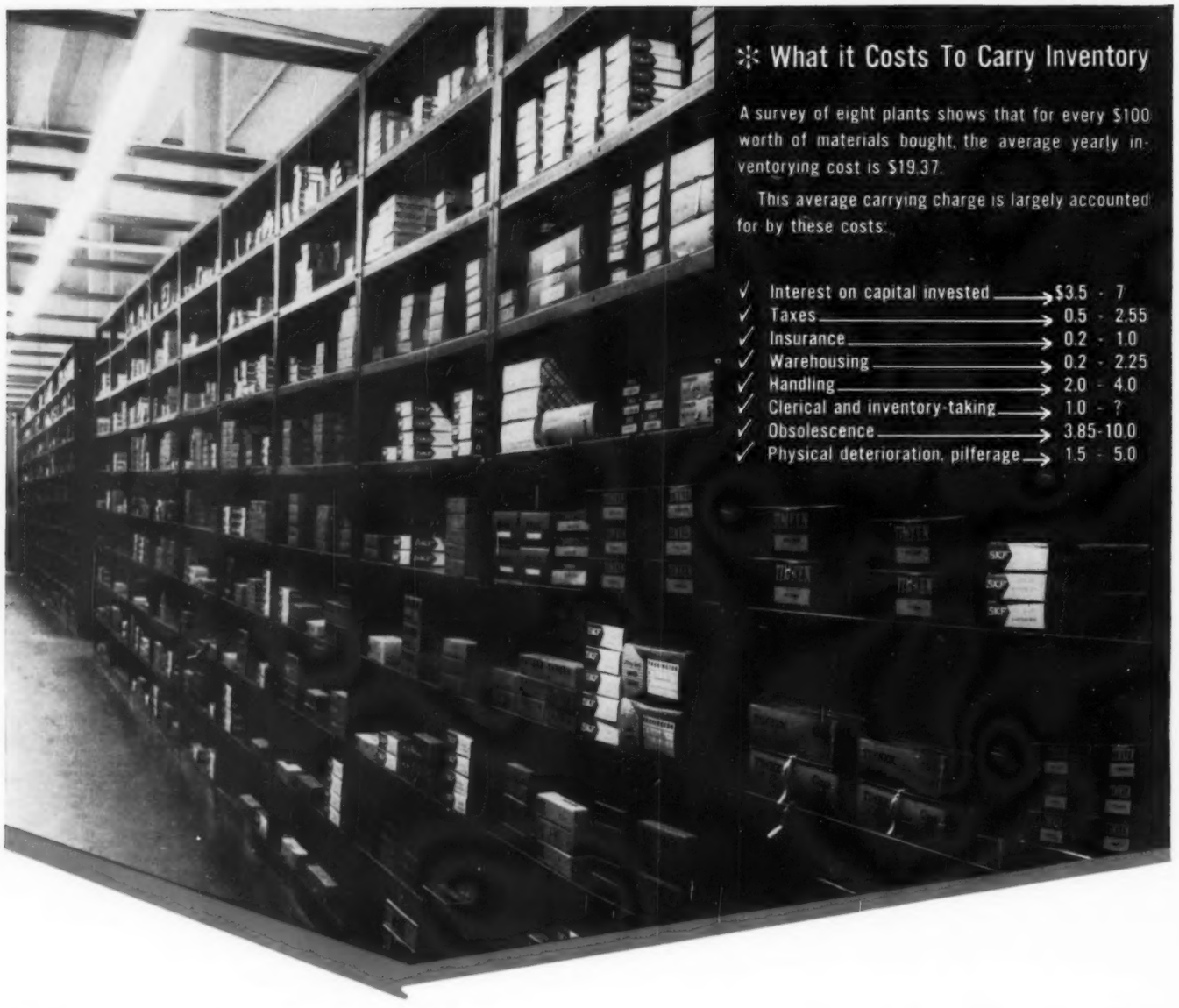
FLOODLIGHTS • CONDULETS • TRAFFIC SIGNALS • AIRPORT LIGHTING



✻ What it Costs To Carry Inventory

A survey of eight plants shows that for every $100 worth of materials bought, the average yearly inventorying cost is $19.37.

This average carrying charge is largely accounted for by these costs:

✓ Interest on capital invested	$3.5 - 7
✓ Taxes	0.5 - 2.55
✓ Insurance	0.2 - 1.0
✓ Warehousing	0.2 - 2.25
✓ Handling	2.0 - 4.0
✓ Clerical and inventory-taking	1.0 - ?
✓ Obsolescence	3.85-10.0
✓ Physical deterioration, pilferage	1.5 - 5.0

Bearings, Inc. can cut your costs on bearing inventory . . . 2 ways!

Inventory costs soak up a lot of dollars that could do much more for your company in other ways. We now perform inventory cost-cutting services for many of our customers and are ready to do the same for you.

First, a bearing survey of the bearings used in the equipment in your plant. We convert manufacturers' parts numbers to bearing numbers. This survey usually shows many identical bearings being held in inventory for different equipment when only one or two bearings will satisfy your immediate needs. A complete record is made of all bearings you actually require and we keep this record up-to-date.

Second, you keep in inventory only a minimum number of bearings to take care of emergencies. Bearings, Inc. guarantees that the branch nearest your plant will stock all the bearings shown on your survey, ready for immediate delivery day or night!

Call or write for a Bearings, Inc. sales engineer to discuss this important, money-saving program NOW! Check our branch locations for the one nearest you.

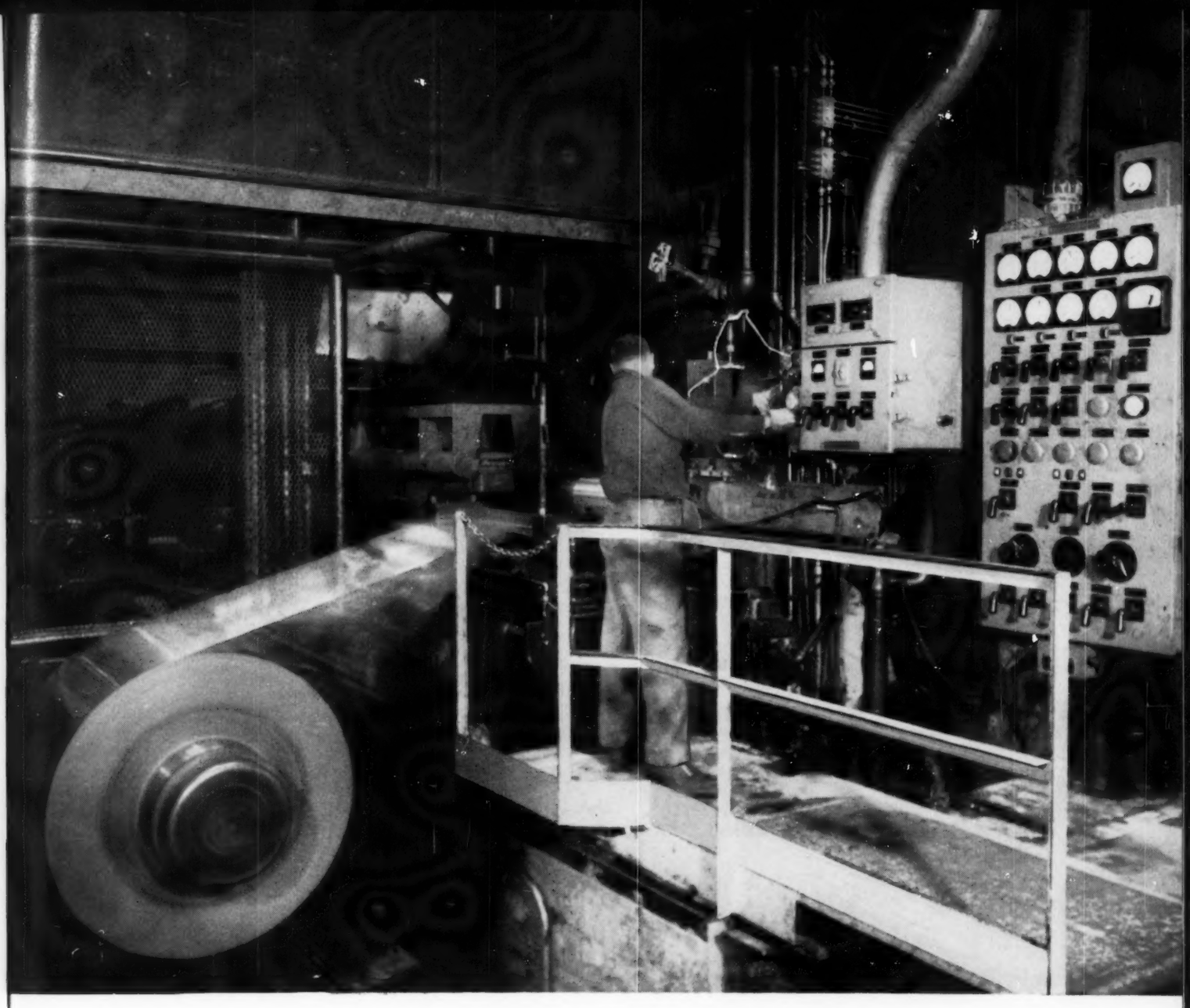
**Reprinted from THE IRON AGE, September 12, 1957.*

Providing bearing service in the North ➤ **BEARINGS, INC.**

OHIO: Akron • Canton • Cincinnati • Cleveland • Columbus • Dayton • Elyria • Hamilton • Lima • Lockland • Mansfield • Toledo • Youngstown • Zanesville
INDIANA: Ft. Wayne • Indianapolis • Muncie • Terre Haute • **PENNSYLVANIA:** Erie • Johnstown • Philadelphia • Pittsburgh • York
WEST VIRGINIA: Charleston • Huntington • Parkersburg • Wheeling • **NEW JERSEY:** Camden
NEW YORK: Buffalo, Balanrol Corp. • **MARYLAND:** Baltimore • **DELAWARE:** Wilmington

and in the South ➤ **DIXIE BEARINGS, INC.**

FLORIDA: Jacksonville • **GEORGIA:** Atlanta • **KENTUCKY:** Louisville • **LOUISIANA:** Baton Rouge • New Orleans
N. CAROLINA: Charlotte • Greensboro • **S. CAROLINA:** Greenville • **TENNESSEE:** Chattanooga • Kingsport • Knoxville • Nashville



J-96121-1

AT 6000 FEET PER MINUTE...

Westinghouse Automatic Gauge Control on Wheeling Steel's New Tin Plate Mill Assures Plus/Minus .0001 Tolerances

In December, 1957, the new five-stand, 6000-fpm, tandem tin plate mill was officially put in service at Wheeling Steel Corporation's Yorkville, Ohio plant. The new 48″ mill has 22,500-hp total drive capacity to produce tin plate and heavier strip at speeds up to 6000 fpm.

Westinghouse equipment is used, entirely, to Power-Up this modern installation. One of the most outstanding new developments utilized is the Automatic Gauge Control, designed and furnished by Westinghouse—a practical necessity on a high-speed mill of this type.

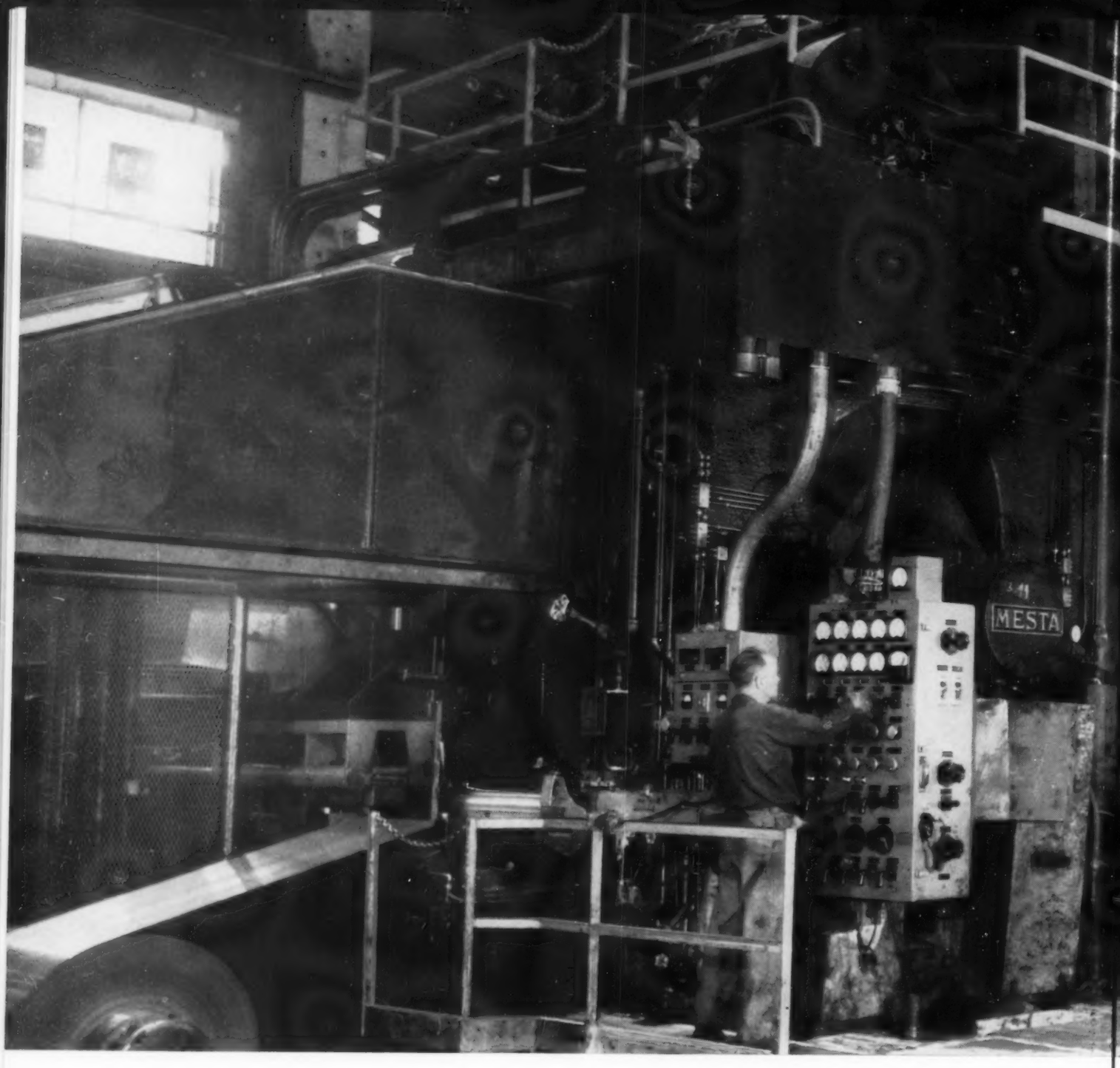
Other Westinghouse equipment furnished for this installation at Wheeling includes: main drive and all auxiliary motors, Magamp* regulators for main drive and variable voltage screwdown controls, M-G sets, brakes, outdoor substations, switchgear, power center, and control centers.

From planning to design, installation and start-up . . . Westinghouse can help you Power-Up. Consult your Westinghouse sales engineer for complete information. Or, write Westinghouse Electric Corporation, 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Pennsylvania.

*Trade-Mark

YOU CAN BE SURE...IF IT'S Westinghouse

Westinghouse Equipment Is Used Throughout the New Five-Stand Tandem Mill at Wheeling Steel Corporation's Yorkville Plant.



New Mill With Automatic Gauge Control Gives More Usable Strip From Every Coil--- Less Production Time Loss

With the automatic gauge control, strip thickness is continually gauged and recorded. Through feedback of signals, the mill automatically adjusts for any variation. Gauge control starts at #1 Stand, controlling the #1 Screwdown to minimize incoming variations. It thereby assures a uniform strip continuously to the mill.

The gauge control at #5 Stand controls the #5 Stand and the reel to adjust the strip tensions and maintain constant gauge of finished strip. The use of this new gauge control assures continuing close tolerance (to within plus/minus .0001) without production slowdown or unnecessary interruption.

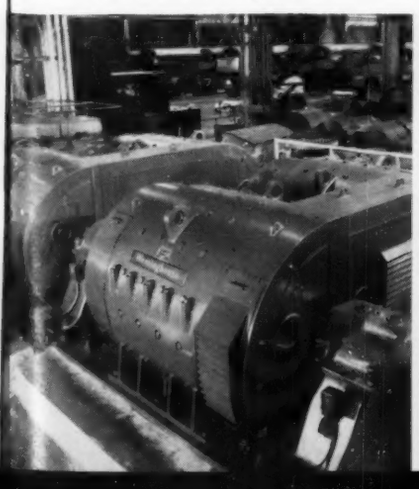
YOU CAN BE SURE...IF IT'S Westinghouse

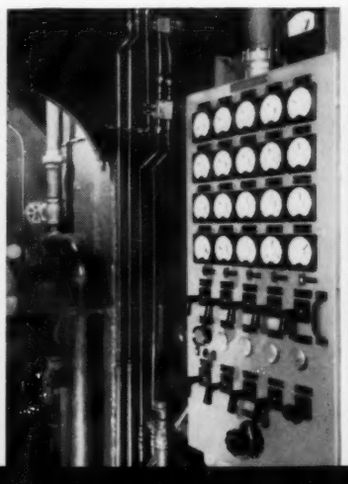
Two 3000-hp double armature motors for #5 Stand twin drive. Side-by-side mounting conserves floor space.

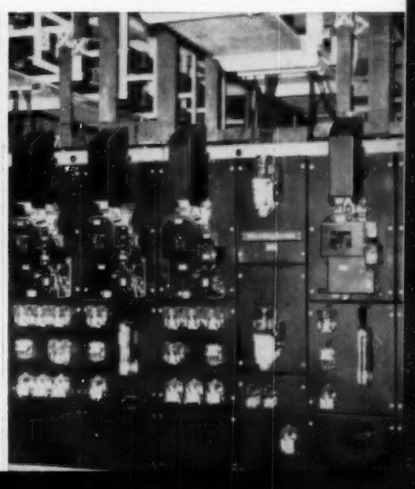
Tensiometer between stands shows strip tensions to guide operators in control of mill, and Westinghouse circular scale meters give maximum readability in minimum panel space.

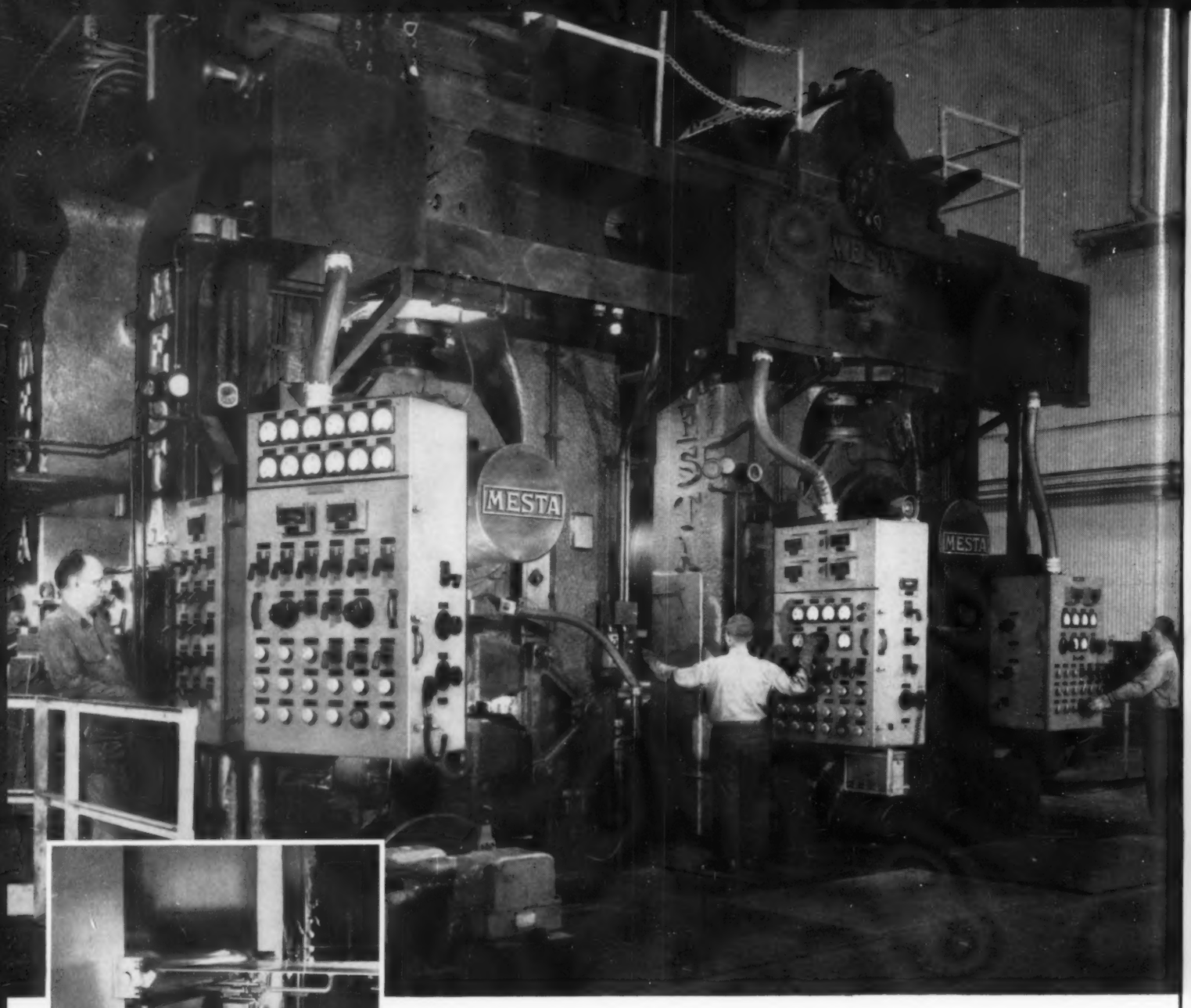
View of motor room showing main and screwdown M-G sets, switchgear and power center. Controls located on balcony at right.

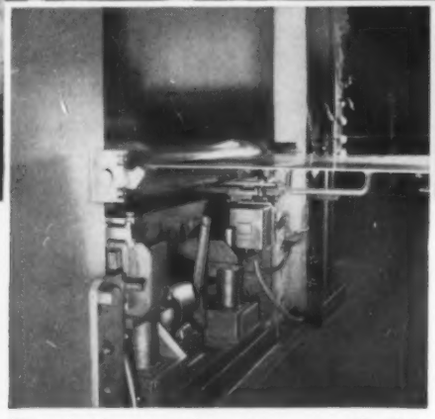
#5 Stand motor and generator line control panels. All circuit breaker and dynamic braking panels are located in basement.





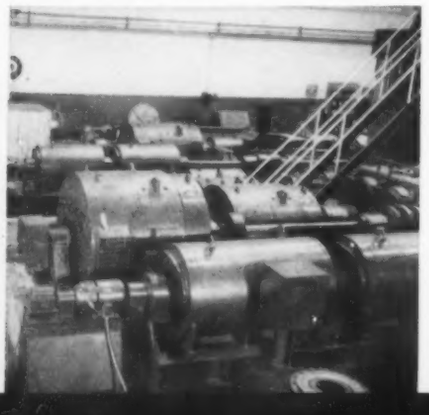






Regulating tensiometer controls #1 Stand to maintain constant tension in strip between stands 1 and 2.

Temper mill main drives. The entry and delivery tension roll twin drives feature special small-diameter machines to enable direct coupling to rolls on 20" vertical centers.



Westinghouse-Powered Temper Mill at Wheeling Gives Higher Tonnage—Less Scrap

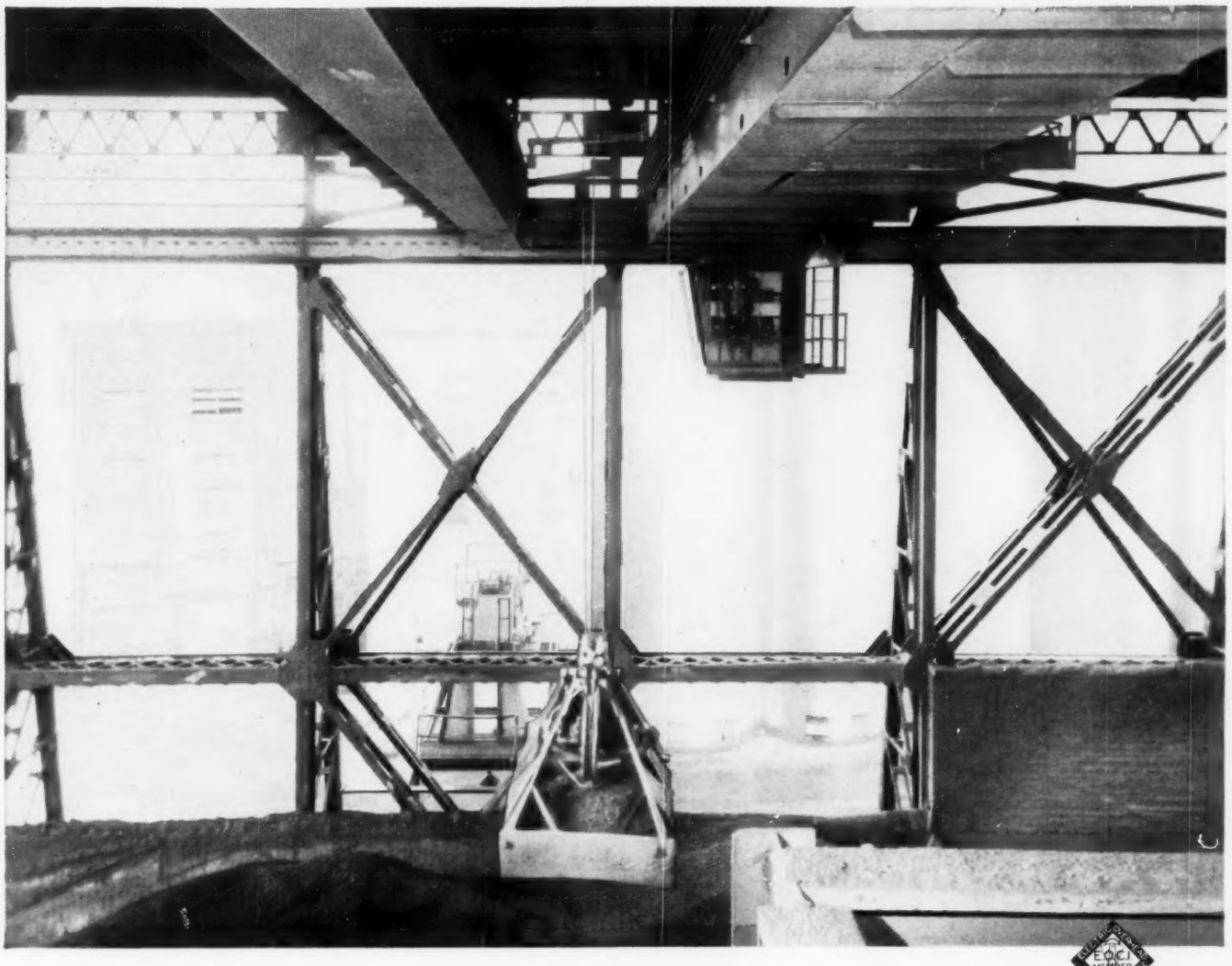
As part of their Power-Up program, the Wheeling Steel Corporation recently installed a new 48" two-stand temper-pass mill, rated at 5000 fpm, equipped with 4600 total horsepower.

This Westinghouse equipped mill has increased the amount of strip produced as well as guaranteeing a better product because of the improved control possible.

Westinghouse equipment furnished includes: main drive and auxiliary motors, M-G set, switchgear, control centers and operating controls.

J-96121-4

YOU CAN BE SURE...IF IT'S Westinghouse



Here's how cement makers

MOVE MORE MATERIALS...FAST...AT LOW COSTS !

Whiting Engineered Cranes are quality-built to stand the gaff of full capacity operation... around the clock, if necessary. That's why Keystone Cement Company of Bath, Pennsylvania, specified this 9-ton Whiting Crane for their materials yard.

The herringbone gears in Whiting Cranes assure long life and quiet, smooth operation. Compact design and all-welded construction cut down dead weight... mean less drag, lower power cost. All moving parts are accessible for fast inspection and maintenance. Every crane is completely wired and assembled *at Whiting* to assure immediate and continued operating efficiency. And complete field service is always available.

For the quality crane that costs least to operate and maintain, talk to a Whiting engineer.

SEND FOR FACT-FILLED BOOKLET ON "WHITING ENGINEERED CRANES"

See the outstanding performance advantages that lead to lowest cost operation. Bulletin 80 gives facts — ask for your copy today. *Whiting Corporation, 15655 Lathrop Avenue, Harvey, Ill.*

87 OF AMERICA'S "FIRST HUNDRED" CORPORATIONS ARE WHITING CUSTOMERS

WHITING

CRANES

MANUFACTURERS OF CRANES; TRAMBEAM HANDLING SYSTEMS; TRACKMOBILES; FOUNDRY, RAILROAD AND CHEMICAL PROCESSING EQUIPMENT

ANY WAY YOU LOOK AT THEM

BUILT TO MEET AISE-NEMA STANDARDS

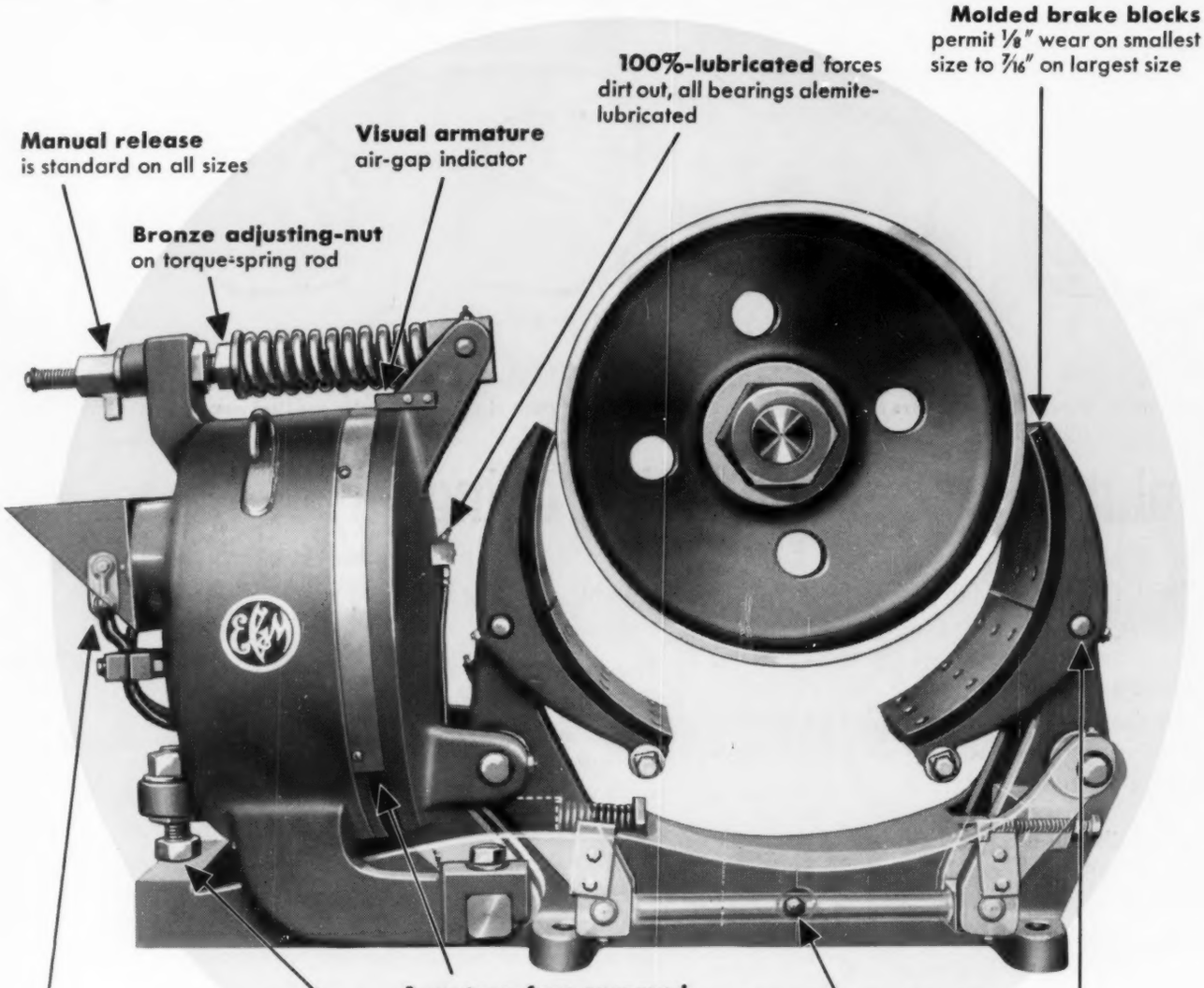
√ Mounting Dimensions
√ Wheel Diameters
√ Torque Ratings

6 SIZES COVER COMPLETE RANGE OF 600-SERIES MOTORS

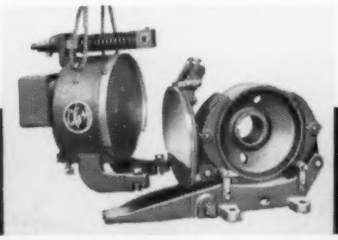
Write for Bulletin 5000

THE ELECTRIC CONTROLLER & MFG. CO.
A DIVISION OF THE SQUARE D COMPANY
CLEVELAND 28 • OHIO

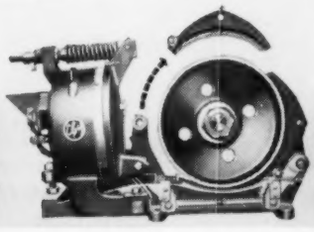
EC&M "WB" BRAKES RATE #1


Molded brake blocks permit 1/8" wear on smallest size to 7/16" on largest size
100%-lubricated forces dirt out, all bearings alemite-lubricated
Manual release is standard on all sizes
Visual armature air-gap indicator
Bronze adjusting-nut on torque-spring rod
Armature-face recessed at bottom allows dust to fall free—prevents clogging
Connecting lever remains **below the brake wheel**
Solderless connectors under protective shield. Conduit connection box is optional
Single adjustment for brake lining wear. Adjusting-nut screws into stainless steel, threaded bushing in magnet-case
Fixed bearing-pins locked with stainless steel set-screws reduce number of lubrication points

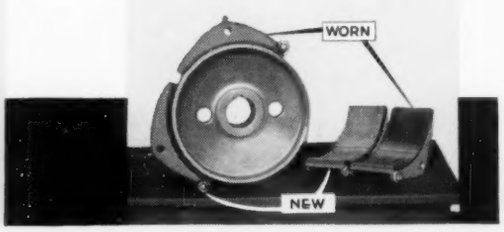
SIMPLIFIED MAGNET REMOVAL



SHOES AND LINERS EASILY REMOVED



ACCURATELY FORMED BRAKE BLOCKS

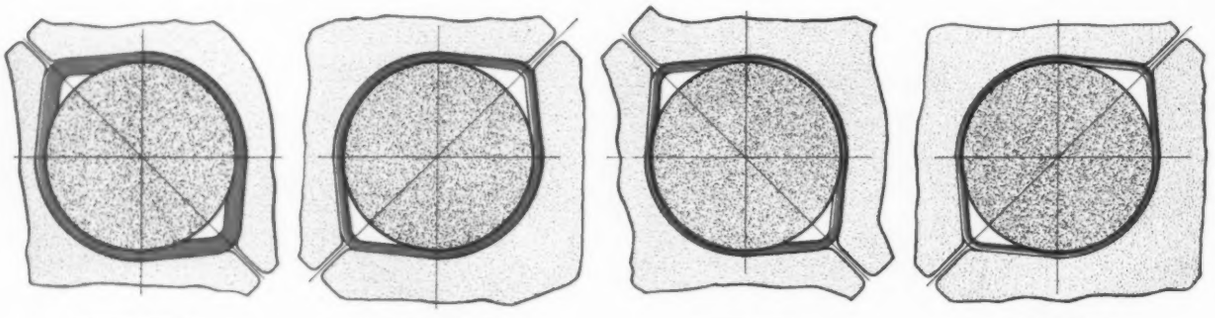


8624

TIPS FROM A ROLL MAKER'S NOTEBOOK

MACKINTOSH-HEMPHILL DIVISION, E. W. BLISS COMPANY, Pittsburgh 3, Pennsylvania

Cast mill rolls • Johnston cinder pots • rotary tube straighteners • end-thrust bearings • heavy-duty lathes • steel and special alloy castings



STAND THREE STAND FOUR STAND FIVE STAND SIX

Severe service conditions at pass edges are shown graphically by these sectional diagrams of various stands of a nine-stand mandrel mill.

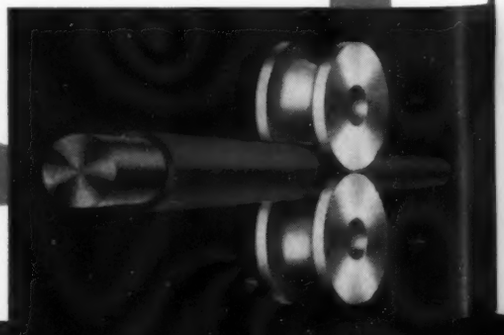
Solutions to some hole-rolling problems

Obviously, there is no single roll analysis to solve all seamless tube mill rolling problems. Nevertheless, in general, once the round has been pierced, the qualities needed in rolls for the later stands—whether the mill be a mandrel mill or a plug mill with reeling and sizing stands—are similar, varying only in degree.

Mandrel mills should get the best—Usually, the most severe operating conditions are to be found in mandrel mills. The rolls must provide high strength, uniform high hardness, resistance to slippage and freedom from scale pickup. The latter quality is especially important in this kind of mill, since the metal of the tube wall is being squeezed between the rolls and the traveling mandrel. We recommend *Midland Superalloy* nickel-chromium-molybdenum alloy steel rolls for this service. Their graphite-free composition and ability to be heat treated to high hardness levels makes them exceptionally resistant to spalling and fire cracking. Hence, they deliver pipe and tubing of top quality, providing long production runs between redressings.

The plug rolling mill process is easier on rolls—Plug mills (high mills), with their following reelers and sizers, place less severe demands on the rolls they use. The reeling stands spread the work over a fairly wide face, and the sizing stands are limited in the amount of reduction they can take by the tendency of the tube wall metal to upset. *Technigrain* or *Nironite AX* alloy iron rolls have the depth of hardness penetration and smoothness of surface needed to provide even wear throughout a complete plug mill set-up. In certain cases, *Technikrome* alloy steel rolls provide the additional strength sometimes needed in the high mill itself.

Whether or not your rolling facilities include seamless tube mills, you'll find that Mack-Hemp can offer you helpful, cost-saving advice on all matters of roll selection and use. Why not call or write us today?

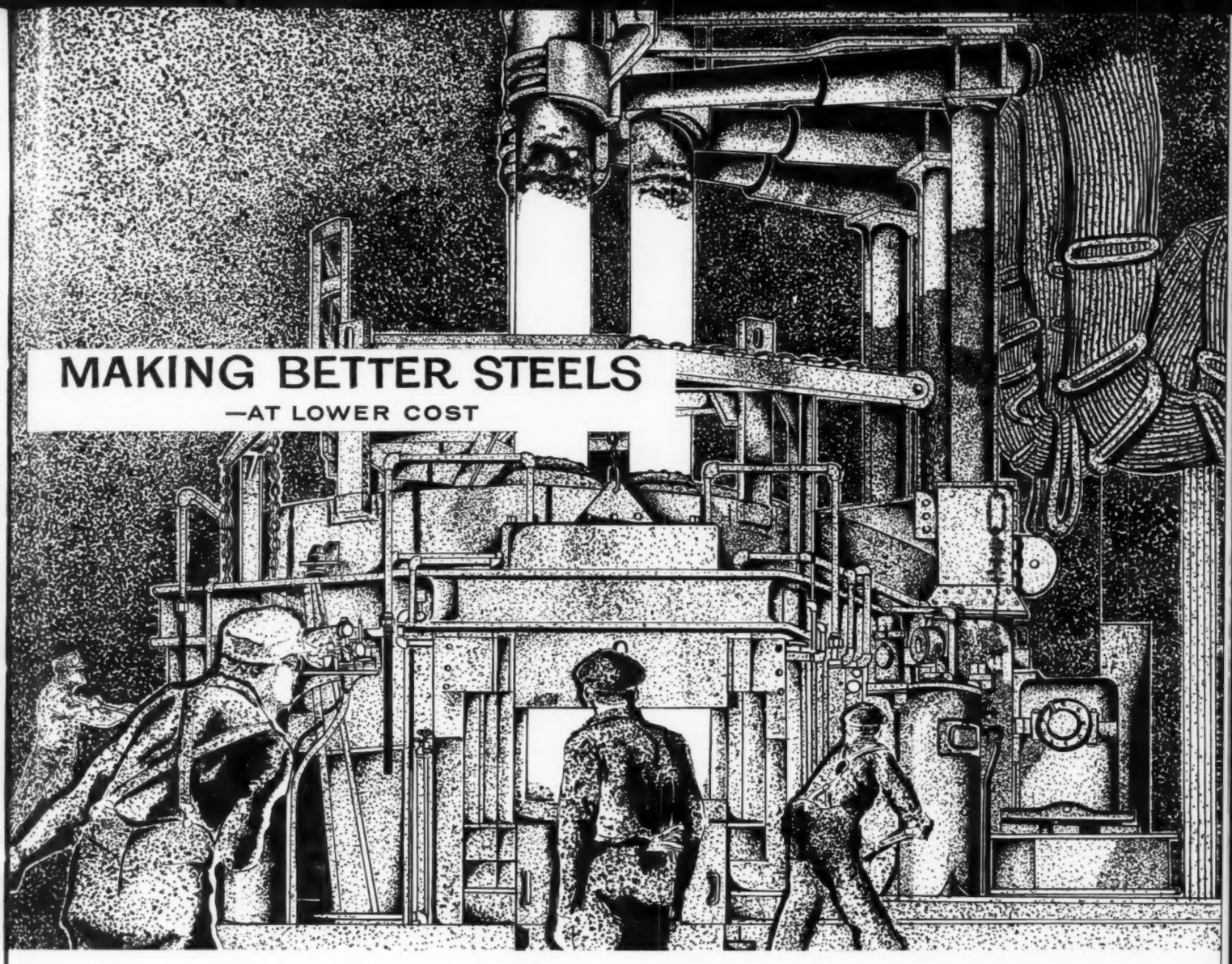


MACKINTOSH-HEMPHILL

You get more tonnage from the rolls with the Striped Red Wabblers

Division of E. W. BLISS COMPANY

Presses, Rolling Mills, Special Machinery



ADDING ALLOYING ELEMENTS

. . . to the bath requires the experience of melters who know how to control the important factors of time, temperature and quantity. Skilled melters also know that a **GLC graphite column with the "weld-strength" Unitrode nipple** helps make better steel at lower cost.

FREE—*This illustration of one of the skills employed by the men who make the metals has been handsomely reproduced with no advertising text. We will be pleased to send you one of these reproductions with our compliments. Simply write to Dept. E-8.*

ELECTRODE GLC® DIVISION

GREAT LAKES CARBON CORPORATION

18 EAST 48TH STREET, NEW YORK 17, N.Y. OFFICES IN PRINCIPAL CITIES

BUILT FOR SEVE

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLE

CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION • COKE PUSHE

THE ALLIANCE MACHINE COMPANY

BRANCH OFFICE MIA

...ERE SERVICE...

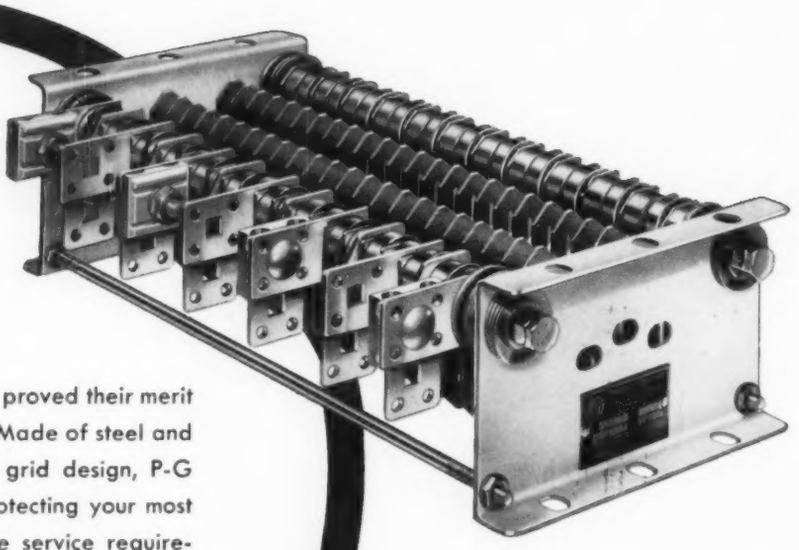
Gantry cranes of all types are built by Alliance Machine Company. The two 60-ton double trolley gantries, illustrated here, are installed at United States Steel's Ohio Works. Each has a 75-ft. span with a 30-ft. cantilever. The main trolley is equipped with a 15-ton auxiliary hoist. The second trolley is equipped with a 20-ton capacity bucket. Both cranes are equipped with an articulating shear leg which permits 12" misalignment (6" + or 6" —) of runway. A card, wire, or phone call to Alliance or Miami will put the "world's largest builders of the world's largest cranes" to work on your particular materials handling problem.

"GIVE US THE RUNWAY AND WE'LL LIFT THE WORLD"

Alliance

MAIN OFFICE • ALLIANCE, OHIO

MIAMI, FLORIDA

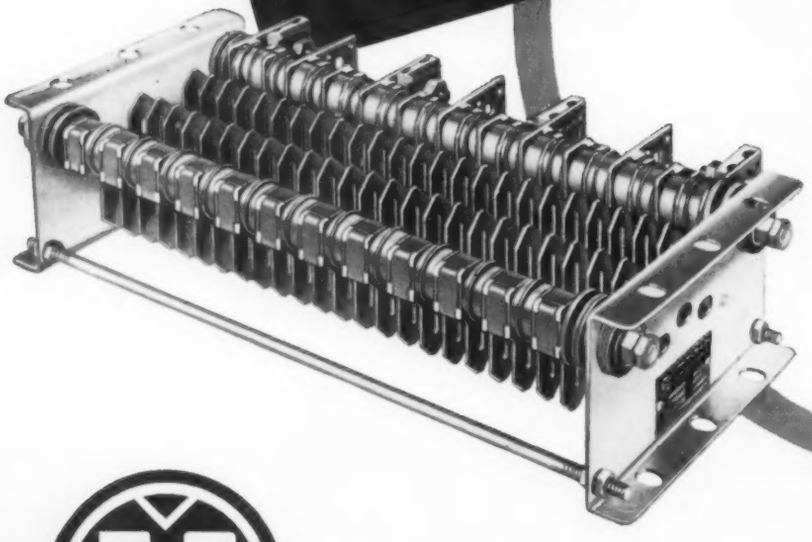


P-G STANDARD

Steel Grid Resistors

These rugged nonbreakable units have proved their merit in all kinds of service for many years. Made of steel and mica, plus P-G unique and exclusive grid design, P-G Standard Resistors are capable of protecting your most vital electrical equipment, even where service requirements are severe. Use of correct resistance value with ample capacity minimizes resistor trouble. ***Write for BULLETIN No. 500.***

P-G has BOTH!



P-G WELDED

Steel Grid Resistors

These units duplicate values of each P-G Standard Steel Grid Resistor. The only change is in adding welding links between resistance grids. Each welding link is made of the same alloy steel used for the grid. These links are heli-arc welded from grid to grid to create a continuous circuit without disruption to the normal path through contact spacers. Thus each P-G Welded Resistor has two paths available for carrying current. Naturally this offers double protection.

Write for BULLETIN No. 510.

P-G

ESTABLISHED 1892

THE **POST-GLOVER** ELECTRIC COMPANY

OFFICE and FACTORY—**Kenton Lands Road, Erlanger, Kentucky**

MAILING ADDRESS—**Box 709, Covington, Kentucky**

Why Mead-Morrison

Coal and Ore Buckets move more material

Mead-Morrison buckets are constructed almost exclusively of lightweight, high-tensile alloy steel that provides maximum payload per pound of bucket weight, less load on the structure, lower power consumption and high resistance to abuse.

They are designed for greater ease of penetration and digging power.

Low maintenance results from design and proper use of high strength material in the bucket. Its riveted—not welded—construction maintains proper shell contour and correct alignment and facilitates field repairs.

A new patented, *non-jamming* jaw linkage is available that obsoletes all other hinge types in the handling of non-crushable material.

The next time you are considering replacing a bucket remember that *the bucket moves the material.*
Cheap, heavy buckets down-rate your entire system.
The higher capacity per pound of bucket weight and the strength of Mead-Morrison buckets guarantee that your overall system is operating at maximum efficiency.

For detailed literature on Mead-Morrison buckets write to: . . .

Mead-Morrison

division of

McKiernan-Terry Corporation

Harrison, New Jersey

MK824

SILICONE RUBBER INSULATED
BY ROCKBESTOS
OFFER YOU:

Excellent dielectric strength — electrical properties remain constant from −130°F to +500°F.

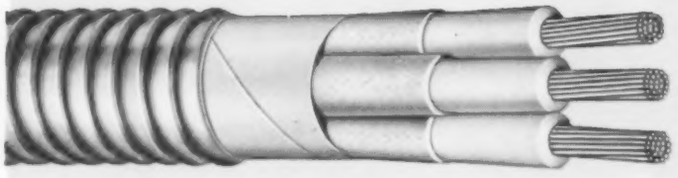
High heat resistance — better than any type rubber insulation. Long service life in temperatures to 125°C (power cables) and 200°C (other applications).

Excellent moisture resistance — unrestricted applications in wet or dry locations — equal to the best grades of rubber. No lead sheath required.

Greater ozone resistance than the best grades of rubber insulated cables.

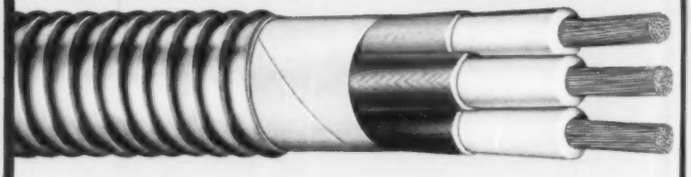
Excellent resistance to chemical attack — being chemically inert, silicone rubber insulations resist effects of lubricating oils and most corrosive atmospheres.

Long life — excellent resistance to weathering and aging.



600 and 5000 VOLT MULTI-CONDUCTOR POWER CABLE

Silicone rubber insulated power cable combined in a 3 or 4 conductor conduit, with interlocked armor overall . . . easily installed with simple supports . . . eliminates conduit . . . greater current carrying capacity for economical power distribution.



MULTI-CONDUCTOR CONTROL CABLE

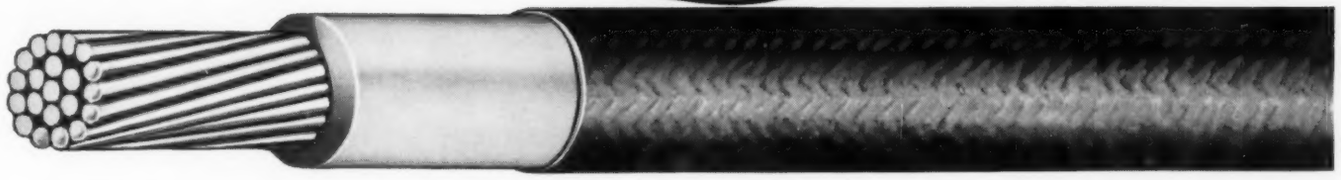
For use in steel mills, power stations, boiler rooms, automotive, ceramic and glass plants as well as other industries where control and signal circuits or control equipment are exposed to high ambient operating temperatures.

ROCKBESTOS PRODUCTS CORPORATION

NEW HAVEN 4, CONNECTICUT

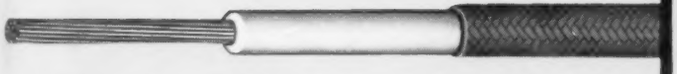
New York • Cleveland • Chicago • Oakland • Los Angeles • Pittsburgh
St. Louis • Detroit • Seattle • Atlanta • Dallas

WIRES



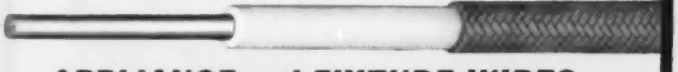
SILICONE RUBBER INSULATED POWER CABLE
600 and 5000 VOLTS

For high temperature circuits either in wet or dry locations, exposed or in conduit. This cable is recommended for use in steel mills, power stations, heat treat areas, boiler rooms, foundries, smelters, etc.



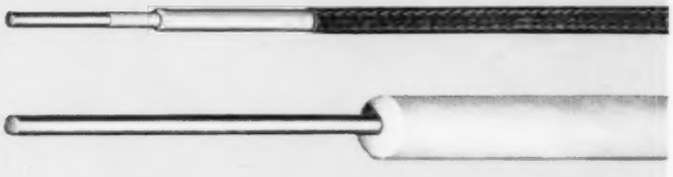
MOTOR LEAD and APPARATUS WIRES

For leads to motors, transformers, etc., requiring a flexible wire in high temperature locations or applications.



APPLIANCE and FIXTURE WIRES

For use in wiring high wattage units when operating temperatures reach 150°C and 200°C. Lighting fixtures, clothes dryers, electronic equipment, stoves, water heaters, ovens, therapeutic devices, space heaters are among the many products for which these wires are recommended.



HEATING CABLES and DEFROSTING WIRES

Heating cables are ideal for use in pipe heating, surface heating, roof de-icing and soil heating.

Defroster wires being odorless and tasteless are perfect for use as rapid defroster heating element in electric refrigerators and freezers.

ROCKBESTOS

For complete details on Rockbestos Silicone Rubber Insulated Wires and Cables send for Catalog SR58.

HOW YOUR PLANT CAN PROFIT FROM THIS MAN'S SKILL. Dowell engineers are experts in the use of chemical solvents to remove scale and sludge—those profit-robbing deposits that cut the capacity of your process systems, tanks, piping. Using the Dowell method of chemical cleaning you get more throughput, less down time—to make possible greater overall plant efficiency.

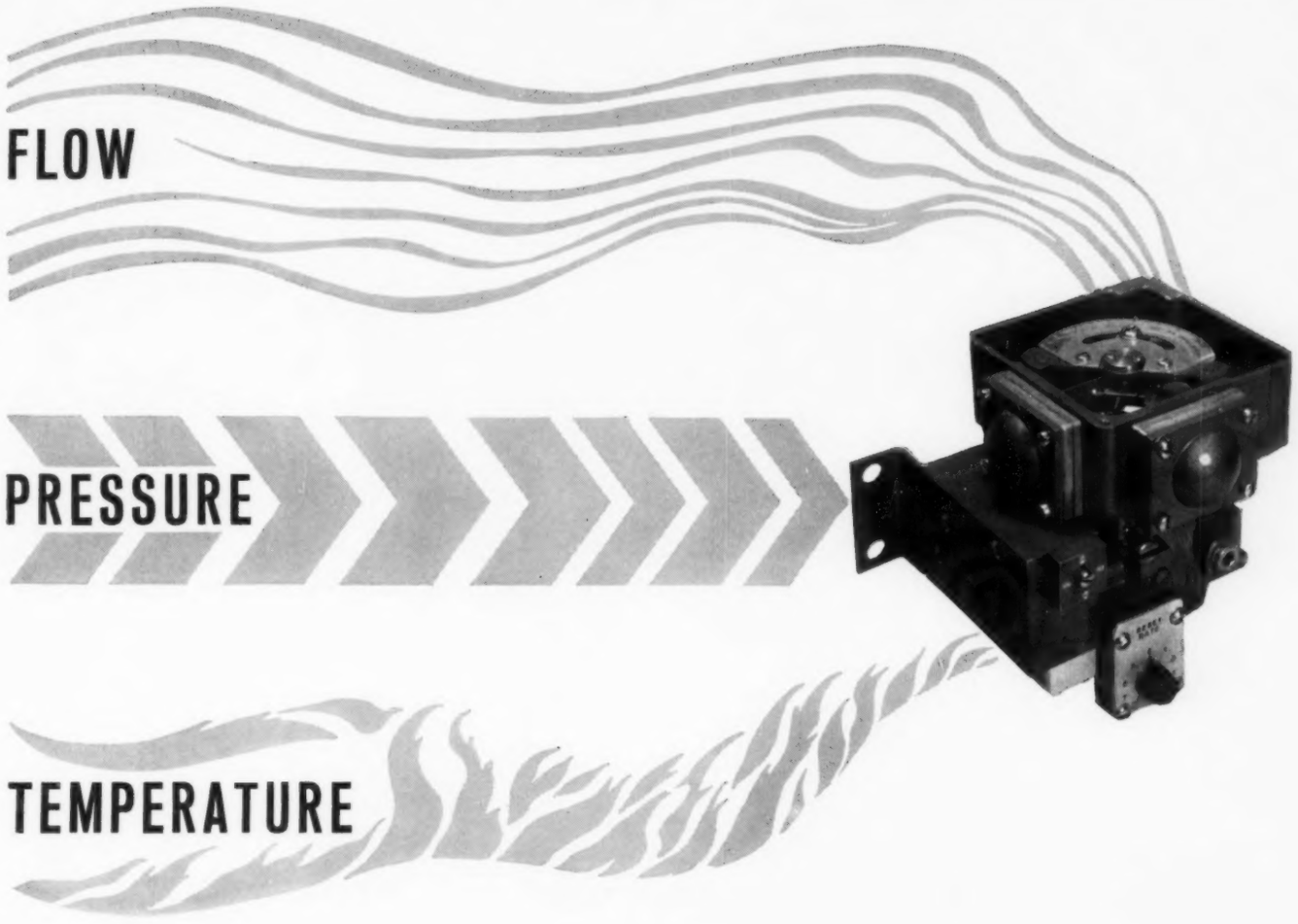
Here's how one corporation employed the skill of the Dowell engineer and his group: Following construction and before the plant was put on stream, the company called in Dowell to remove mill scale.

Total cost of this mill scaling service was $5000. Once in production the plant did not have a single major shut-down for maintenance due to mill scale. Management of the plant credits Dowell service with helping them net an operating profit of somewhere between 10 and 20 times the cost of the chemical cleaning. That amounted to between $50,000 and $100,000 the first year.

With Dowell service you get 15 years experience in chemical cleaning, full lines of equipment and chemicals—plus an engineered job—performed by trained crews.

Every type of industry can profit from Dowell methods of chemical cleaning. Ask your maintenance and operating engineers if they have all the facts—the profit possibilities—on Dowell service. DOWELL—A SERVICE DIVISION OF THE DOW CHEMICAL COMPANY. Headquarters and research center, Tulsa 1, Oklahoma; 165 offices and stations to serve you.

Chemical cleaning services for industry DOWELL



Control Any Process Variable

with a system based on

REPUBLIC'S NEW TYPE "VC" PNEUMATIC CONTROLLER

Here is an all purpose null-balance-vector controller for use with any pneumatic transmitter. Its proportional band ranges from 2% to 500% *without changing parts*, for quick adaptation to changes in process requirements. Especially important in high-precision control, Republic's Type VC has exceptional sensitivity and a narrow dead band (less than 0.05%). Its high capacity non-bleed pneumatic amplifier consumes little air, keeps output ample. A selector block permits reverse or direct action. Local or remote pneumatic set point optional.

Companion instruments—using an identical null-balance-vector "heart"—include differential pressure, temperature and pressure transmitters . . . ratio, totalizing, multiplying, squaring and square - root - extracting relays. Many parts are interchangeable among the instruments in this "family". Besides reducing spare parts inventory, the similarity of components simplifies the task of training personnel.

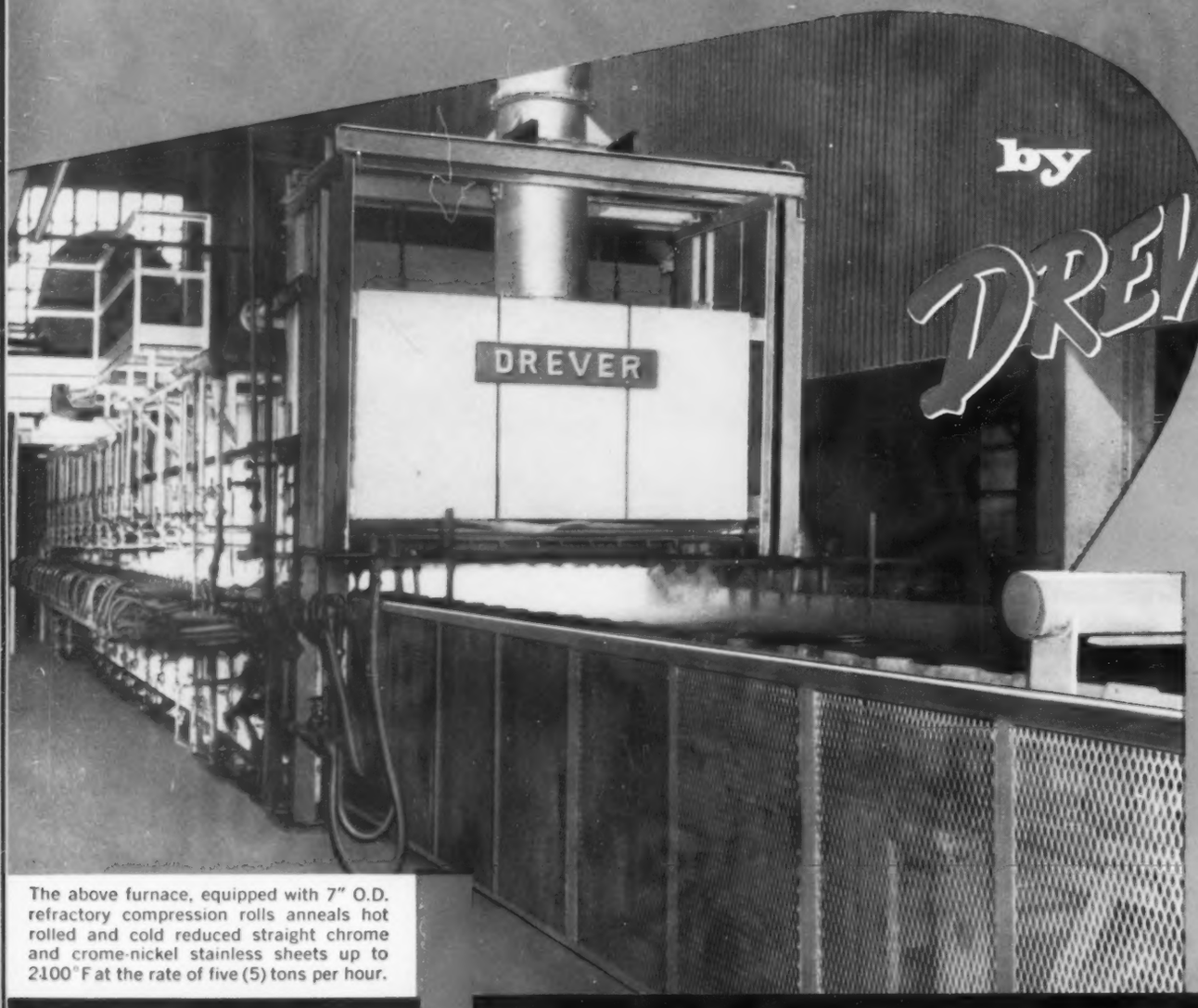
Let a Republic engineer show you how these instruments can help to achieve accurate, efficient, dependable control systems. Republic Sales Offices are located in principal cities throughout the U.S.A. and Canada.

REPUBLIC
FLOW METERS CO.

Subsidiary of ROCKWELL MANUFACTURING COMPANY
2240 DIVERSEY PARKWAY CHICAGO 47, ILLINOIS
In Canada: Republic Flow Meters Canada, Ltd.—Toronto
Manufacturers of electronic and pneumatic instrument and control systems for utility, process and industrial applications.

ROLLER HEARTH FURNACES

for Operation at 2300°F Utilizing Drever Refractory Compression Rolls



by DREVER

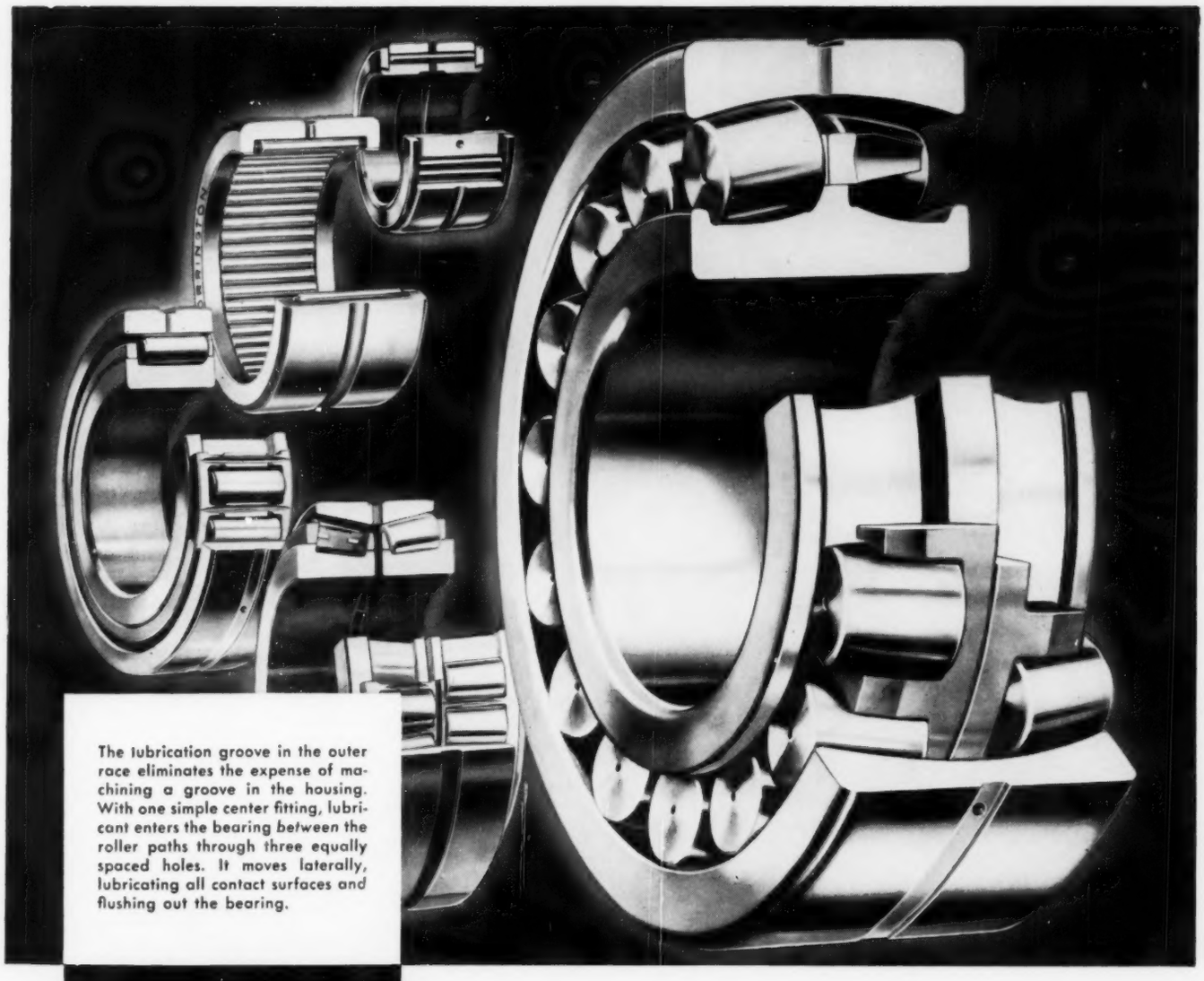
The above furnace, equipped with 7" O.D. refractory compression rolls anneals hot rolled and cold reduced straight chrome and crome-nickel stainless sheets up to 2100°F at the rate of five (5) tons per hour.

The success in utilizing the Drever Refractory Compression Roll in annealing stainless steels has been attributed to the roll strength and its resistance to pickup which completely eliminates the necessity of using rider sheets. The refractory rolls are prestressed and consist of silicon carbide sections retained by spring loaded alloy ends to allow for expansion and to provide axial forces to insure structural stability under rated load. Furnaces have been installed with roll sizes varying from 4½" O.D. x 20½" long to 14" O.D. x 14'-6" long.

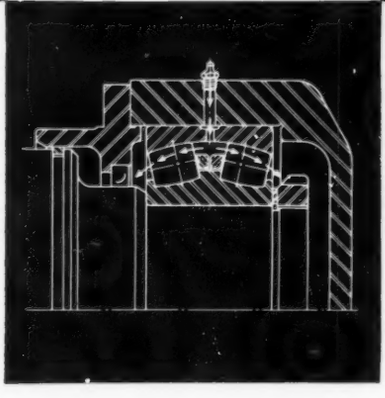
In addition to annealing stainless steel sheets, plates, bars and tubing, materials have been successfully heat treated at 2300°F. Avail yourself of the experience of Drever Company engineers in solving your stainless steel annealing problems.

DREVER COMPANY

RED LION ROAD and PHILMONT AVE., BETHAYRES, PA.



The lubrication groove in the outer race eliminates the expense of machining a groove in the housing. With one simple center fitting, lubricant enters the bearing *between* the roller paths through three equally spaced holes. It moves laterally, lubricating all contact surfaces and flushing out the bearing.



A time-proved lubricating method now available on Torrington Spherical Roller Bearings

The circumferential groove in the outer race has met the test of experience in many Torrington Bearings, including Heavy Duty Needle Bearings, Aircraft Type Needle Bearings, Tapered and Radial Roller Bearings. Now the circumferential lubrication groove is available in Torrington Spherical Roller Bearings.

This design feature makes it possible to introduce lubricant *between* the roller paths without the expense of machining a groove in the housing. This groove is proportioned to provide generous lubricant flow capacity. Lubricant moves through the roller paths, flushing used lubricant and contaminants away from bearing contact surfaces.

Torrington Spherical Roller Bearings in many sizes may be ordered with this groove as desired at no additional cost. For further information, see your Torrington representative or write: **The Torrington Company, South Bend 21, Ind.—and Torrington, Conn.**

TORRINGTON BEARINGS

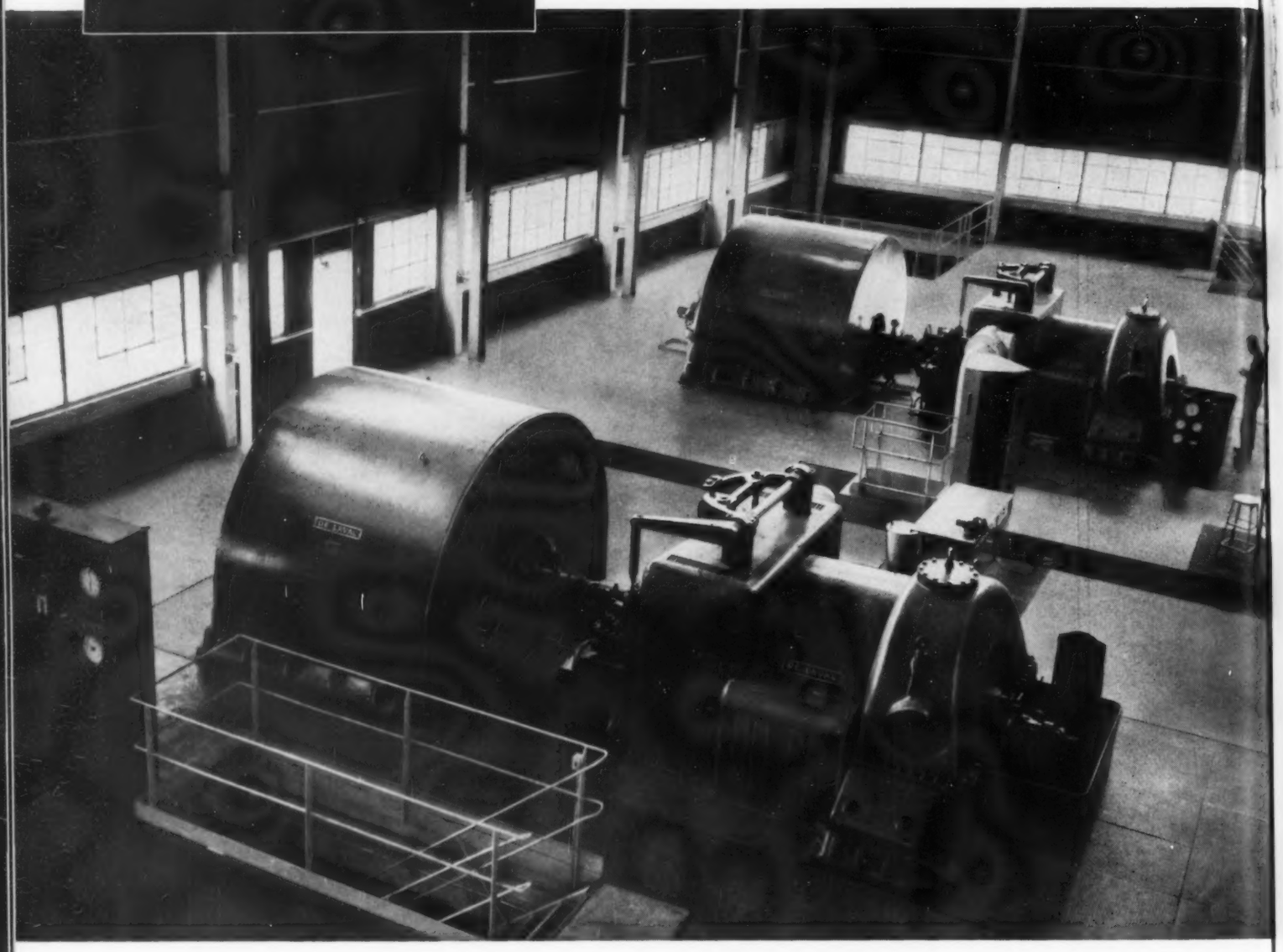
District Offices and Distributors in Principal Cities of United States and Canada

SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • NEEDLE • BALL • NEEDLE ROLLERS • THRUST

DE LAVAL

BLAST FURNACE BLOWERS

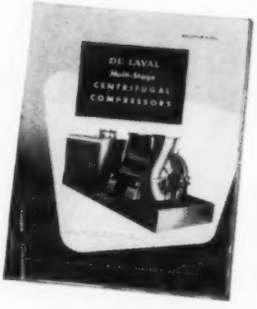
deliver 110,000 cfm each for McLouth Steel



These two De Laval turbine-driven centrifugal blowers do a round-the-clock job in the McLouth Steel plant, Trenton, Michigan. Each has a rated capacity of 110,000 cfm of air; discharge pressure is 30 psig. Each is driven by a 12,400 hp, 2950 rpm De Laval steam turbine operating under steam conditions of 600 psig, 825 F with 2″ hg.

De Laval compressors are designed individually for each application to assure maximum efficiency and range of operation. Construction is rugged throughout. Casings and perfectly balanced rotors are built to take punishment. All parts are precision-made to limit gages. Materials are selected which will best meet the particular conditions of corrosion, pressure and temperature.

De Laval centrifugal blowers are built in single and multi-stage types to supply air in volumes up to 150,000 cfm for all classes of service in steel, gas and coke plants. The wealth of application experience acquired by De Laval over the years assures a correct and economical solution to your blower problem.



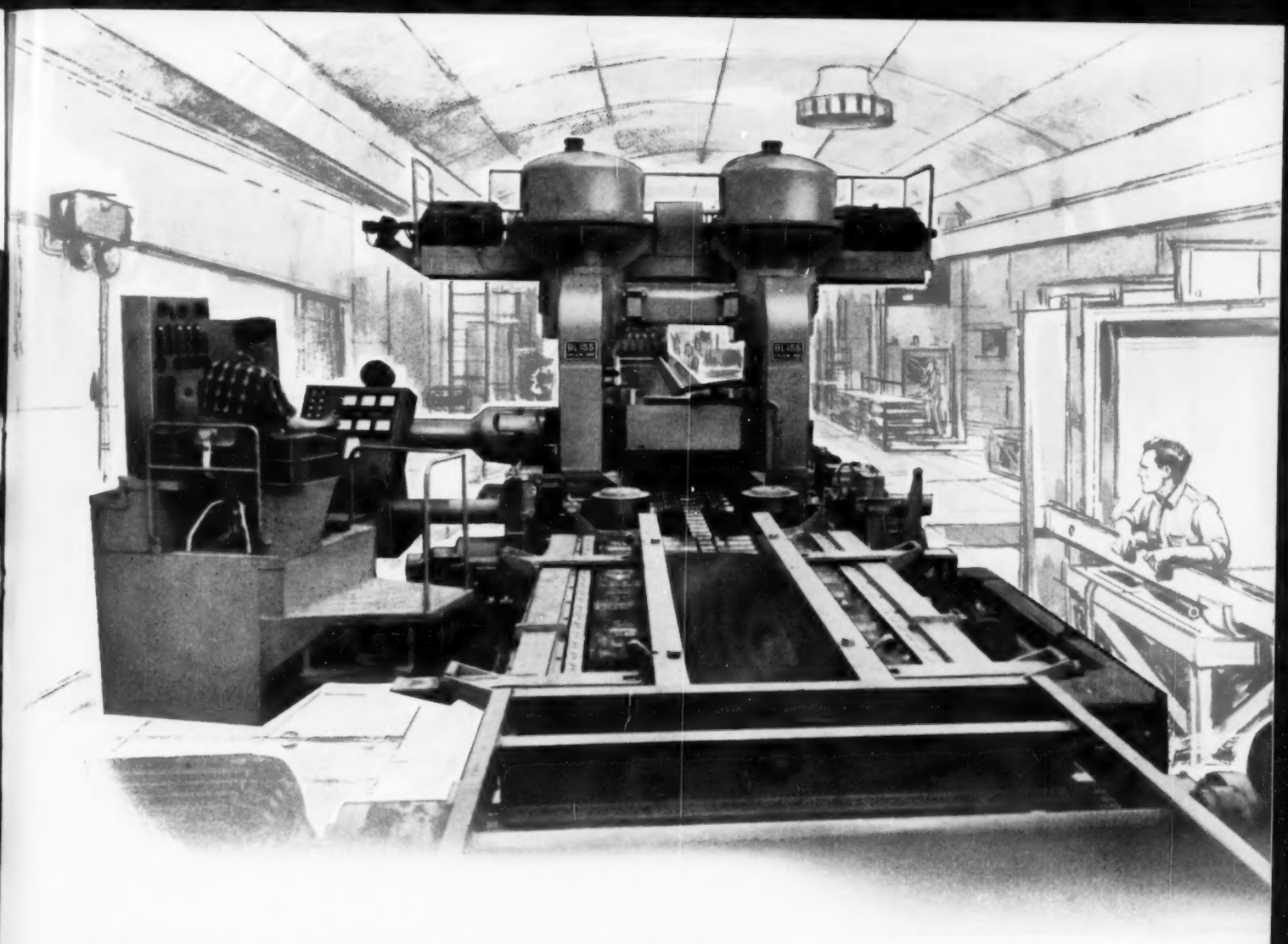
Send for Bulletin 0504

DE LAVAL *Centrifugal Blowers*

DE LAVAL STEAM TURBINE COMPANY

870 Nottingham Way, Trenton 2, New Jersey

OL 360

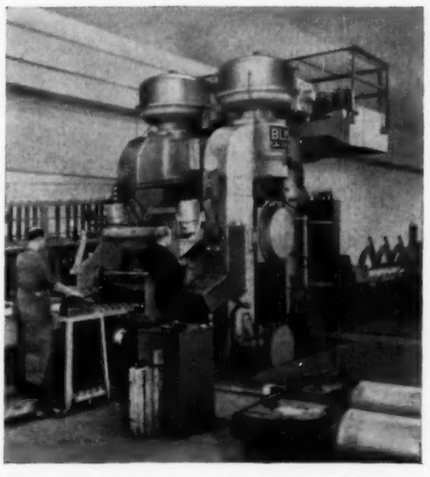


Bliss mills roll brass within a Norwegian mountain

Some 120 kilometers north of Oslo, buried deep underground in the side of a mountain, is Raufoss Ammunisjonsfabrikker, Norway's state-owned, privately operated consumer goods and munitions producing company, a prime supplier to the NATO nations and an important cog in the defense of the West.

Helping Raufoss play this major role are two Bliss-built rolling mills—a 30″ x 52″ two-high hot reversing mill used for rolling aluminum, brass and mild steel up to a meter wide (39.37″), and a 16″ and 34″ x 34″ cold reducing mill for rolling brass up to 30″ wide. These mills, helping to turn out the weapons of defense, are also used by Raufoss to produce the strip it uses to stamp out a wide variety of components for industry's everyday needs.

This installation is just one more example of the acceptance of Bliss rolling mill equipment, both in the U. S. and abroad. Learn how Bliss has engineered other installations—ferrous and non-ferrous. Simply write for a copy of our 84-page Rolling Mill Brochure, Catalog 40-B.



This 16″ and 34″ x 34″ cold combination rundown and finishing mill can roll material up to 30″ wide.

BLISS
SINCE 1857 ®

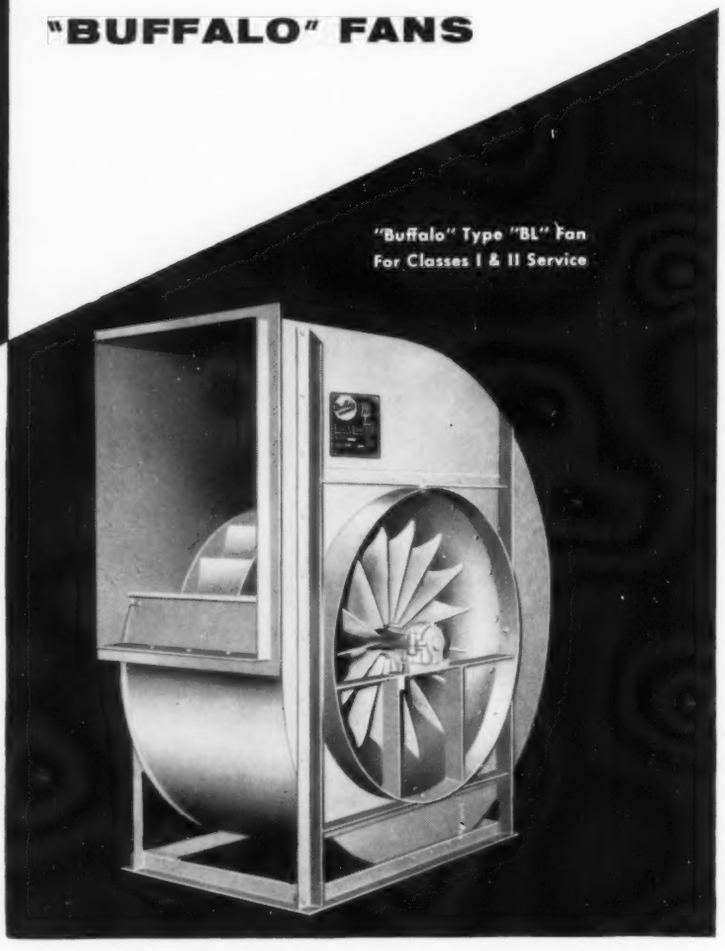
Bliss is more than a name . . . it's a guarantee

E. W. BLISS COMPANY, Rolling Mill Division, Salem, Ohio

Subsidiary: The Matteson Equipment Company, Inc., Poland, Ohio

MINIMUM MAINTENANCE, LONG LIFE ASSURED BY THESE HEAVY-DUTY "BUFFALO" FANS

"Buffalo" Type "BLH" Fan
For Classes III & IV Service



"Buffalo" Type "BL" Fan
For Classes I & II Service

The high performance characteristics of these two outstanding "Buffalo" Fans has resulted in their widespread use in the field of industrial air handling. In addition to offering peak-efficiency operation in their respective classes, both the "BL" and the "BLH" bring you a bonus economy factor of *maintenance reduced to an absolute minimum* throughout a long, productive life. This minimum maintenance factor is directly due to unusually rugged "Buffalo" construction features such as:

HOUSINGS — The heavy gauge sides and scroll are of all-welded construction. Heavy structural steel bracing provides housing stiffness and rigid bearing support. Flanged inlets and outlets give added support.

SHAFTS — Hot-rolled or forged shafts are ground to close tolerances for perfect wheel and bearing fit.

WHEELS — Sturdy backward-curved blades are welded to the die-formed shroud and welded or riveted to the solid backplate. Heavy hubs assure permanent shaft alignment. For higher tip speeds, reinforcing rings provide necessary wheel rigidity.

BEARINGS — Self-aligning anti-friction bearings are designed for continuous operation at maximum tip speed. Horizontally split, ring-oiled, self-aligning, babbitted sleeve bearings are also available.

For full details, contact your "Buffalo" representative, or write for Bulletins F-102 and F-200.

Minimum maintenance is assured by the famous "Q" Factor — the built-in QUALITY that provides trouble-free satisfaction and long life in every "Buffalo" product.

"Buffalo"

BUFFALO FORGE COMPANY

173 Mortimer Street • Buffalo, N. Y.

BUFFALO PUMPS DIVISION, BUFFALO, N. Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING

NATIONAL TRADE-MARK brushes cured this balky power shovel...and helped 14 other mines!

M. B. INMAN

Constant brush trouble on a power shovel led this mining company to call in "National" Carbon Brush Man M. B. Inman. His recommendation paid off so promptly he was asked to check recurring exhaust fan trouble at another company-mine.

Here Burt recommended brushes that could ride the fans' high speed commutators without burning. Next, the company asked Inman to survey all of its brush-using equipment. RESULT: a plan that simplified ordering, insured good performance and reduced inventories *by stopping duplicate ordering.*

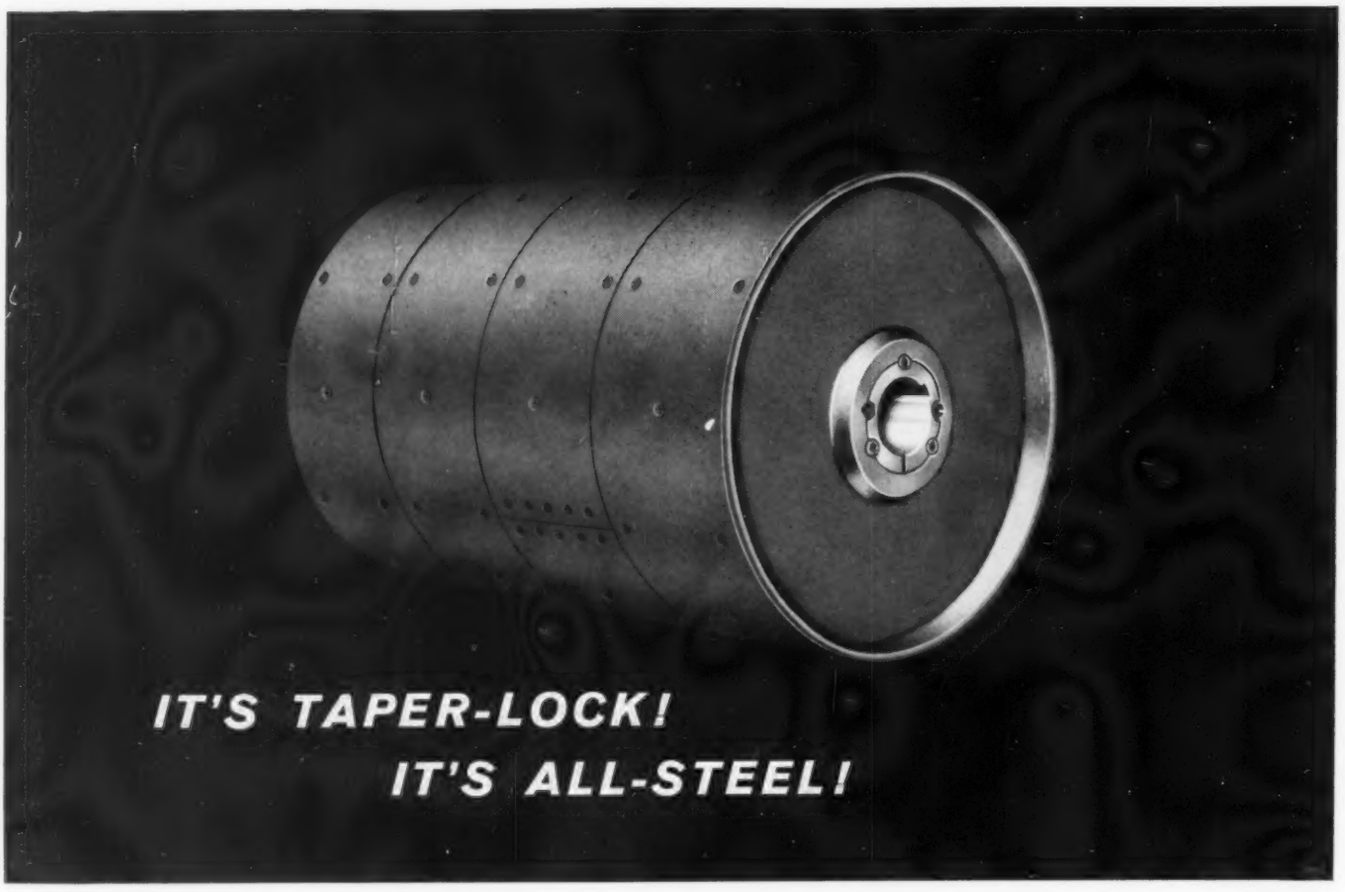
The "National" Brush Data Survey idea soon spread to every company-mine in the state... then to all mines in the neighboring state—15 mines in all. This is typical of the service provided by your "National" Brush Man. Call him today, or write National Carbon Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, New York.

UNION CARBIDE

"National", "N" and Shield Device, and "Union Carbide" are registered trade-marks of Union Carbide Corporation

NATIONAL CARBON COMPANY • Division of Union Carbide Corporation • *30 East 42nd Street, New York 17, N. Y.*

Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco. *In Canada:* Union Carbide Canada Limited, Toronto.



The modern Conveyor Pulley for superior performance . . .

One tough application after another proves beyond doubt that you can't beat a lagged, Taper-Lock Steel Conveyor Pulley for the hard jobs! Here is the score on their use in rugged coke plant service. In this particular case the installation was on belts from the quencher and loading belts to cars. The report was made after *three years of use.*

1. **One-third saving on initial cost.**
2. **Saving on maintenance; no redressing of pulley faces.**
3. **No appreciable wear on lagging.**

In addition, these Taper-Lock Steel Conveyor Pulleys provide the further benefits which are inherent in their design:

1. **No bolts to shear.**
2. **Easy on — easy off.**

Taper-Lock Steel Conveyor Pulleys have terrific impact capability. All welds are made by the submerged arc process for 100% strength. Taper-Lock's patented back-up bar permits a weld of the full rim thickness to give 100% penetration. And there are no bolts to give way!

Normally available from stock in all face widths and diameters from 6 inches to 8 feet. *Write for bulletin.*

DODGE MANUFACTURING CORPORATION, 5900 Union St., Mishawaka, Ind.

CALL THE TRANSMISSIONEER your local Dodge Distributor. Factory trained by Dodge he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

DODGE
of Mishawaka, Ind.

APPLETON type "ECC"

explosion-proof, dust-proof cable connector

(CLASS I, GROUPS C and D; CLASS II, GROUP G)

UL approved

A factory-sealed, explosion-proof connector used between a portable extension cord and an explosion-proof unilet or housing

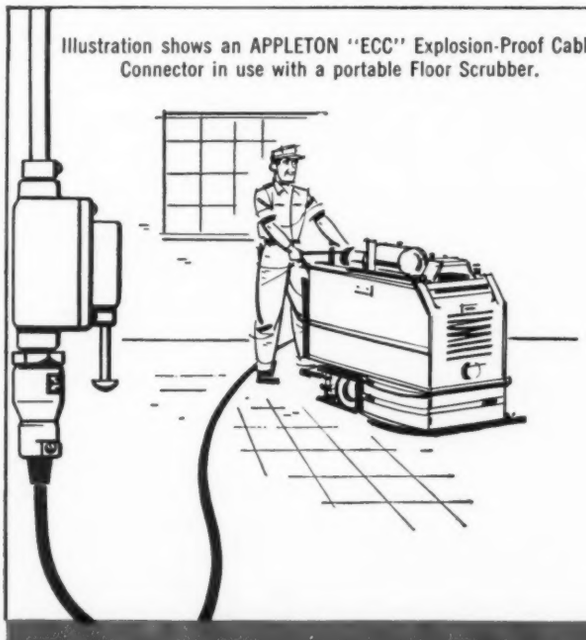


Illustration shows an APPLETON "ECC" Explosion-Proof Cable Connector in use with a portable Floor Scrubber.

From its rugged aluminum housing which withstands years of extreme rough usage, to its lead wires protruding 12" from the body for faster, easier splicing, this APPLETON "ECC" Connector has every desirable quality feature.

The current carrying lead wires for example, are solidly moulded into the connection blocks: can't work loose under vibration. An auxiliary cord clamp is provided to prevent strain on the wire connectors resulting from sudden tugs on the cord. This clamp fastens tightly by screw pressure on a tapered rubber bushing in the form of a sleeve... effectively sealing the cord entrance. Three pressure-type solderless lugs on the load end of the "ECC" allow quick connections to be made with Type S Rubber-Covered Cord in ranges of #18 to #12, AWG. The grounding connector is plainly identified with a letter "G" on the block. Only the APPLETON Type "ECC" Explosion-Proof, Dust-Tight Cable Connector offers so many worthwhile features for such an economical price.

Sold Through Franchised Distributors Only

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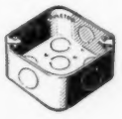

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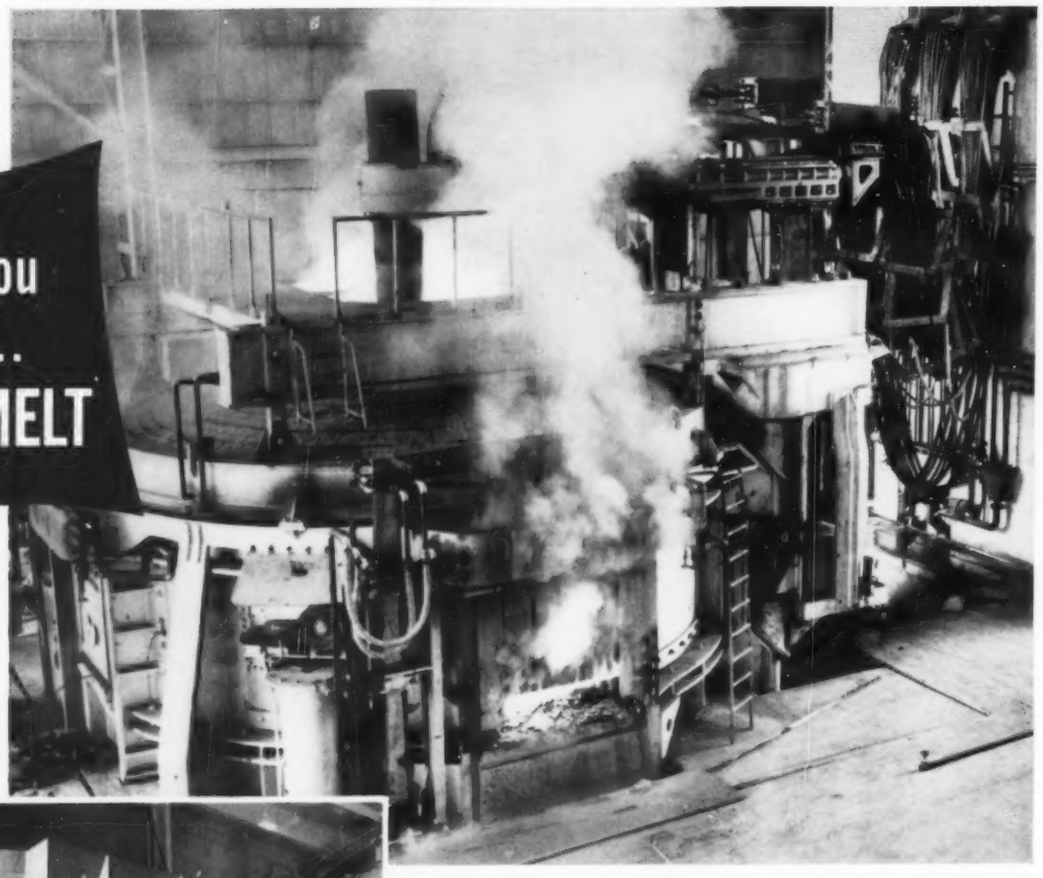

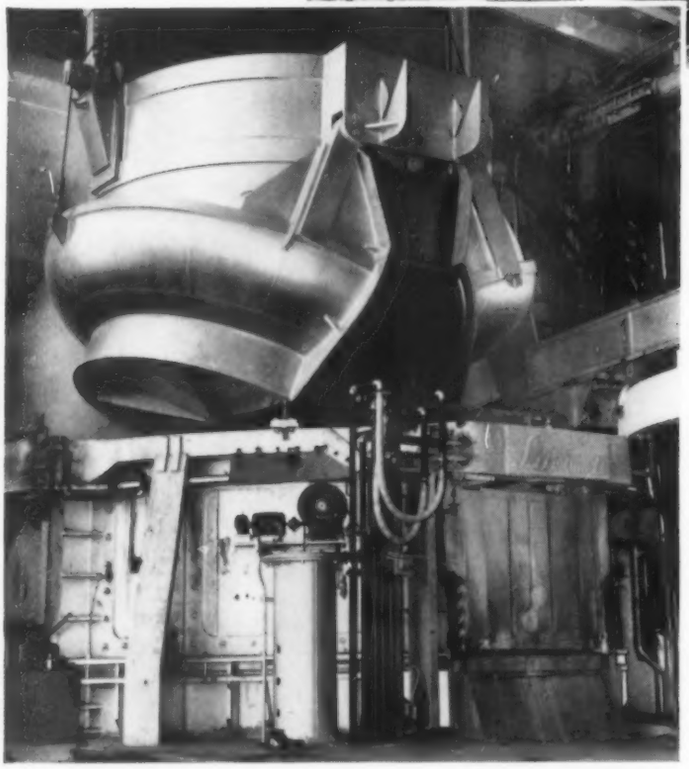

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STANDARD SIZES UP TO TWO HUNDRED TONS CAPACITY

PROGRESS—Past and Future

by C. L. Huston, Jr., President, Lukens Steel Co., Coatesville, Pa.

. . . . progress of all industry, including steel, in the past 50 years indicates that gigantic steps can be expected in the next 50 years . . . .

IT is a privilege to join with the Association of Iron and Steel Engineers on the occasion of its 50th Anniversary and to salute AISE for its accomplishments of the past half century while, at the same time wishing for equal achievement in the next 50 years. If technical advances continue at the present pace, it is entirely possible that the AISE will celebrate its 100th Birthday in their homes and plant stations with multiple television hookups permitting quick and easy discussion while miles apart.

The AISE merits the approbation of all industrial management for its contributions in the direction of streamlined mechanization, equipment standardization and more efficient maintenance techniques. Through this organization, a meeting place is established where men with common interests and talents can exchange experiences, seek information and establish working arrangements that are mutually helpful and which, in turn, make the men more valuable in their profession as well as to the companies they represent.

Unquestionably, AISE programs and group acitivities must make for long life, maintenance of vigor and constant forward thinking. A former superintendent of our electric department—Fred H. Woodhull—now on the company's retired roll, in Pittsburgh on the AISE 50th Anniversary in September, 1957 was honored as one of the two living charter members of AISE. Within the past year he celebrated his 85th Birthday, married for the second time, and toured the New England states on his honeymoon. He drives to Florida each winter and maintains an active interest in the Association of Iron and Steel Engineers, his church and community affairs.

As a point of added interest, another retired Lukens Steel Co. electric department superintendent—Walter Burr—served twice as chairman of the Philadelphia Section and was president of the National Organization in 1935 when its name was changed from the Association of Iron and Steel Electrical Engineers to its present designation.

The subject of this talk "Progress—Past, Present and Future," is about as broad as it possibly could be and affords opportunity to talk about almost anything. Possibly the AISE program committee recognized that I am not an engineer and felt I might better approach my talk using the shotgun rather than the rifle technique.

The steel industry is particularly aware of the operating and maintenance engineers' contribution because 1957 is the Steel Centennial and we have had reason to review past history. As steel's first century began, politically free Americans lived in almost the same kind of iron age that existed in Egypt as early as 800 B.C., following an earlier age of copper and bronze. Food was raised with horse-drawn plows. Though coal was coming into use, charcoal was also still employed in ironmaking. The industry conducted in the mills of the day had not heard of technology, mass production or standardized parts as we know them today. Iron machines—as in the textile or grist mills of New England had long been run by water power; but the use of steam was increasing as railroads made coal available.

The offices and mills of 1857 were generally cold places for workers in winter. The first building to be steam-heated was the Eastern Hotel in Boston in 1845. Homes usually had one or two rooms heated with fire wood. Iron stoves were costly luxuries, and fireplaces were still in common use as the chief means of keeping warm.

Most of the rails for the country's railroads had come from Great Britain. In 1844 the first iron rail was rolled in America.

It is interesting to note that 100 years ago the U. S. Treasury had total receipts of $69,000,000 while reporting expenditures of $68,000,000. The people were practically exempt from direct federal taxation. Some might observe that in this area there has been the greatest change.

Between April of 1856 and the end of 1857, a coming revolution in human affairs was launched quietly in patent papers issued to two men—Henry Bessemer in England and William Kelly in America. They had reported discovery, almost at the same time, of a pneumatic process that was to introduce the mass production of steel.

First American steel made by the Bessemer-Kelly Pneumatic Process was in 1861, when a converter designed by William Kelly was used experimentally in Johnstown, Pa., by the Cambria Steel Works. In 1864, the first commercial Bessemer Converter was erected in Wyandotte, Mich., by the Wyandotte Iron Works. It could produce two and one-half tons of steel in one heat.

In 1865, in Chicago, the first Bessemer Steel Rail was rolled. In only four years iron, and then steel, rails would span the continent. About two years later, pig iron was first produced on the west coast near Portland, Ore. In 1868 the first open hearth furnace was constructed in the United States, and at almost the same time, in 1869, steelmen in Worcester, Mass., erected the first continuous rod mill.

The steel industry celebrated its first million-ton year in 1879. Bessemer Steel, in that same decade, was adopted to the manufacture of wire nails which became an important step in promoting the building of homes.

The first steel beams were rolled in 1885 and, two years later, such beams were used in the construction of a Chicago office building. Seamless steel pipe was introduced in the United States in Pennsylvania in 1895, just five years after America had reached the status held ever since—the world's greatest steel producer.

The electric furnace, key to the making of fine alloy steels, appeared in 1906. World War I spurred industry to its utmost to support the allied effort, and in 1917 America's steel industry, for the first time, produced over 50,000,000 tons of this essential material.

In 1918 Lukens installed the world's largest steel plate rolling mill, a mill destined to gain wide recognition throughout the industry and to become known as "The Big Mill" or "The 206," which is the number of inches in its width.

The continuous hot strip mill was born in 1923 and that was a major step forward in the history of steel Body steel in modern automobiles and refrigerators are only two of numerous products resulting from this development.

The late twenties saw the first commerical production of new, special purpose steels: stainless, rustless, corrosion-resistant. The mid-thirties ushered in electrolytic tinning of steel sheet. And the first year of World War II brought the continuous electrolytic tinning line to apply thin, uniform coatings of tin on steel. Over 4,000,000 tons of this steel went into the manufacture of 39,000,000 "tin" cans in 1955.

The pressures of World War II and the advancing American technology in which the AISE played so large a part combined to create dramatic new national emergency steels to conserve alloying materials, and "high temperature" steels to meet the tests of jet engines and ultrasonic speeds.

More recent years have seen the development of continuous casting, of the oxygen converter, of electrical steels to feed the growing electronics industry, of steel for the atomic energy program, to mention but a few. Never before has the steel industry moved ahead in so many areas with today's speed.

In no modern nation was ironmaking and steelmaking a more primitive undertaking than in the United States of a century ago. In no country today can iron and steel production compare with that of the United States either in efficiency or volume.

The practical engineering profession did much to make possible today's position of the steel industry. In the early days few if any engineers were in iron and steel plants. Men rose through the ranks learning how to build, repair and operate the various steelmaking machinery. Frequently they knew "how" but not "why." It was not until competition forced new machinery, new methods and greater speed upon the industry that engineers came into their own beyond the design stage. For example, in our own company, Pete Haldeman, who for many years was a member of the AISE organization, was the first graduate engineer employed by Lukens and that was around the turn of the century when Lukens, incidentally, was almost 100 years old.

Surveys show that while employment has been growing over the past several years, clerical and executive people are being added to the work force at a much slower rate than technically trained personnel. Steel mills today are full of complicated machinery and more is being added. At our new steel plate processing and finishing plant, for example, some of the key workers spend their day watching a television screen. This is not for the sake of entertainment but to give them a bird's eye view of the whole process which is directed remotely by the operators at their control panels. The intricate combination of electronics and mechanics governs substantial tonnage production of a variety of steel qualities.

Only about twenty men are needed to control operations on each of the three shifts which are involved in continuous 24-hour production in this plant which was built at a cost of $10,500,000. Plants such as this one are constant reminders of the skill of the operating engineer who in modern times is as essential to insure uninterrupted full production as the design and construction engineers are to their phases of the project.

We might take a look at what has happened to the graduate engineer in the plant over the past half century or more. When he first made his appearance on the iron and steel operating scene, he was viewed generally with suspicion, disdain and amusement in mixed quantities. What sort of practical training could possibly come from books and figures? The only way to learn the steel business was the school of hard knocks and a long indenture of tough work and keen observation to get the feel of things. How could this brain in a white collar do anything except upset proven established techniques and probably upset, too, those who had learned through long years of experience?

Even in that early stage, the ability to understand people and know something of human values and relationships was an important factor in determining the success or failure in the introduction of the engineer to steel plant operations. Many "first" fell by the wayside for lack of this quality and served to delay in their companies the acceptance of their constructive service which today is known as a must if real operating progress is to be achieved.

Gradually the wisest of the practical operators began to see real value and help to them and to company operations in the service of these trained engineers. Attitudes of disdain and amusement gradually gave way to recognition and respect. Suspicion lessened in similar degree as with experience together and the development of common understanding and language, the practical men and the engineers found that they needed each other. In more recent years there is seldom heard this distinguishing difference between the "engineers" and the "practical man." Today, except in strictly plant engineering work, it is not easy to note in general contact with plant supervisors which have engineering backgrounds and which have learned principally from experience supplemented by technical studies. Even the governing bodies for state professional engineer ratings are certifying, as meeting their high standards, individuals who, without formal engineering education, have achieved the required qualifications.

In this general area of technical training, those who have studied the general industrial picture have pointed up to us a problem which will have to be handled in the future. The rapid advances in the technical requirements of the steel industry are making it necessary for us to attract technically trained idea men of a creative nature in increasing numbers. These people are inherently nonconformists and generally difficult if not impossible to meld into a team operation. Again, we must find ways and means to accommodate ourselves to their work with us, as well as to attract them to and hold them within our organizations. Other industries are competing actively for the services of such people who are limited in number.

It is clearly evident from our brief review of progress —past and present—in the steel industry that technical training, refined by practical experience, is a vital factor to continuing progress. There is another factor, however, which also requires our considered attention. I refer to the search for and development of management talent.

Do we insist, and will the industry insist, that our future supervisors and executives will be trained and experienced engineers? I believe the answer in the matter of preference generally will be "yes," but the nod in final selection will go to the individual who has demonstrated the greatest degree of vision and leadership, whether or not he has a technical background. There are, of course, the practical considerations of the shortage of technically trained personnel and the fact that many engineers will elect to develop professional status within their own specialty rather than turn toward industrial management.

The budding age of atomic energy, man-made satellites, transportation faster-than-sound, and instantaneous world wide communication place ever increasing demands upon those in positions of leadership. Ever present, at the same time, are the problems of rising prices and costs which must be answered with increased and more efficient productivity. Never has competition been keener.

Many who are thrilled by outstanding engineering achievements in competitive industry know too that profits must accompany engineering accomplishment for continued growth and success of the enterprise. Over the years the concept of profit has changed materially. We at Lukens feel reasonable and improving corporate income must be earned in line with other basic objectives such as mutually profitable and constructive relationships with the groups with whom we deal—such as customers, suppliers, stockholders, financial institutions, employees, government and community neighbors.

Of course, fundamental as ever to leadership is the relative ability to get things done through people. In competitive industry, the leader today must be vastly better informed than his forebearers. There are company policies and standard practices to be assimilated. There are established rules of conduct in relation to subordinates and associates which must be explained and maintained.

The newly-hired employee assigned to your department expects you to be able to discuss understandably with him the innumerable pamphlets he received from the employment department when he is hired. These include company history, operating processes, safe practices, the union agreement and the social insurance program. Your own supervisors expect you to know the current status of your department's performance and cost achievement against established goals and the specific reasons if some things are not up to par.

Your neighbors in the community count upon you to explain your company to them and to set them straight upon erroneous rumors and other misunderstandings.

Top management regularly reviews and evaluates your standing as a supervisor and leader and your potential for advancement. In long range planning, time has a way of passing quickly. It takes years to develop new markets and new products. It takes careful planning in advance to have men ready as needed to handle new and broadened responsibilities and to solve foreseeable problems.

There is a constant change within the management structure as the business grows and adjusts itself to new markets, new operating processes and new political and economic conditions. Respected leaders leave the management roster through retirement, death and other reasons. Their place is taken by those deemed most able and ready to carry on the leadership responsibilities.

For many years past, the Lukens Steel Co., as an example, has had an active and continuous program of future planning for the corporation as a whole as well as for each of its component organizations. Included in the endeavor has been constant emphasis on supervisory and executive development. As our business has grown, able men have been ready to move into greater responsibilities. Sometimes this has been occasioned by a single replacement: sometimes caused by a substantial reorganization of a department or a division.

Now as to progress in the future, maybe we should turn to the comics for a preview of what is to come. Perhaps we shall all be wearing wrist radios so that we can keep in touch with the folks at home while, wearing an anti-gravity belt, we jump through the sky on a trip to the store in town. We may have an atomic powered automobile which will be able to rocket to the moon for weekends.

Of more direct and definite interest to us in the steel industry, however, is the firm knowledge that a growing population both at home and abroad will require increasing tonnages of steel at a rate for the forseeable

future which will be limited only by the means of financing, available raw materials and technical assistance. There will be increasing emphasis on special purpose steels. Increasing attention will be paid to automation and complex quality and production controls. Traditional steelmaking methods and facilities will undoubtedly give way to such developments as direct reduction of raw materials into semifinished and finished products, less costly equipment for the production of pig iron and ingots, and so on.

We have dwelt at some length upon progress in the past and present, and how the engineer earned his spurs in the steel industry. There will be vastly increased demands for his services in the future of our industry.

We have also indicated the importance placed upon management development within the industry to help us do a better job today while preparing for assignments in the future. This effort will undoubtedly be expanded as new problems and responsibilities broaden the qualification requirements for supervisory personnel.

No one can say definitely, of course, what tomorrow will bring. The appearance of sputnik makes some of the facetious things I have mentioned seem not nearly so fantastic as they might otherwise have been.

Regarding the future, there is one thing in which we have a firm belief for our own company's progress; that is, from the minds and determination of the younger people moving along will come, as the years go by, practical and profitable new markets and facilities beyond our comprehension today. It is management's job to support this belief by adding regularly to our organization men of high caliber and talent.

As we reflect on the outline of future progress for the steel industry as a whole, I think we can safely say that the nature and rate of its development will depend upon these same fundamental considerations. ▲

Available Translations

As a service to readers of the Iron and Steel Engineer a list of translations from foreign articles is being printed intermittently. Articles selected for this listing will be those thought to be of primary interest to the American steel plant operator. Those papers listed with a number only may be obtained from the Cooperative Translation Service, The Iron and Steel Institute, 4 Grosvenor Gardens, London, S.W. 1, England. The titles with a BT in front of the number may be obtained from H. Brutcher, P.O. Box 157, Altadena, Calif., U.S.A. All correspondence concerning price, ordering, and so forth should be directed to one of the preceding sources.

757 BLAIN: "Preset Reduction Skin-pass Mill," *Tech. Mod.*, 1957, pp. 103–104.

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672 LEMM: "Layout of High-capacity Rolling Mills for Light-steel Sections and Wire Rod," *Stahl u. Eisen*, 1957, Sept. 5, pp. 1181–1195.

639 REIMANN: "Automation in the Cold Rolling Mill," *Stahl u. Eisen*, 1956, Dec. 13, pp. 1665–1668.

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660 SPILLER and FUNKE: "Investigations on a 4-high Reversing Mill Stand Rolling Cold Strip for Tinplate. Part I—Measurements to Determine the Power and Work Required and the Degree of Utilisation; Part II—Effect of Rolling Force, Rolling Speed, Strip Tension, and Amount of Lubrications Used on the Trueness to Dimensions of Cold-rolled Strip," *Stahl u. Eisen*, 1957, June 27, pp. 867–881.

740 MATVEEV: "The Tube Industry of the U.S.S.R.," *Stal*, 1957, Nov., pp. 997–1005.

697 GELEJI: "Measurement and Calculation of Rolling Pressure and of Power Demand on the Pilger Tube-rolling Mill," *Acta Tech. Acad. Sci. Hung.*, 1956, No. 1–2, pp. 205–218.

798 WOLF: "Possibilities of Standardising the Drives of Steelworks Cranes," *Stahl u. Eisen*, 1957, Jan. 10, pp. 33–36.

+ 892 ANTONI: "Accidents in the German Iron and Steel Industry 1956—Works Accidents Statistics" (Abridged).

589 FACKERT: "Structure of Scale on Hot Rolled Strips and Sheets," *Stahl u. Eisen*, 1955, Dec. 15, pp. 1705–1710.

767 MULLER and MARX: "Results of Testing the Operation of Blooming Mills, Part I—Methods used in Measuring the Characteristic Data in Rolling Blooms," *Stahl u. Eisen*, 1957, Oct. 31, pp. 1577–1582.

831 FRIEDRICH: "Effect of Steelmaking Procedure on Billet Quality and Seamless Tube Yields," *Hutnicke Listy*, 1957, Dec., pp. 1077–1083.

898 KHLEBNIKOV et al.: "Rational Rail-pass Design," *Stal*, 1957, No. 12, pp. 1103–1107.

761 KHARASH et al.: "Problems in Sinter Production," (Including a Description of a 2000-sq ft machine), *Stal*, 1957, No. 2, pp. 106–114 (Abridged).

816 EGGERS: "The Mottling of Tinplate," *Arch. Eisenhuttenwesen*, 1957, Dec., pp. 777–783.

739 KOPINECK: "Rapid Determination of Iron in Slag" (with an accuracy of ±2 per cent, within 4 minutes), *Arch. Eisenhuttenwesen*, 1956, Dec., pp. 753–760.

927 BARANOVSKII and PINUS: "Automation of Open Hearth Furnaces by Electronic Apparatus," *Metallurg*, 1958, No. 2, pp. 15–17.

BT 4052 POKRYSHKIN: "Effect of Increased Top Pressure (in Blast Furnace) upon Composition of Pig Iron Produced," *Stal*, 1957, No. 6, pp. 487–492.

A Review of European Steel Plant Progress—1957

by R. C. McMichael
Assistant to Manager of Steel Plants
Lukens Steel Co.,
Coatesville, Pa.

European steelmakers are doing an excellent job despite handicaps in available raw materials, transportation and manpower . . . . many excellent ideas were picked up by Lukens Steel management on their European trip which are being incorporated in Lukens expansion program.

IN the early part of 1957, a group of Lukens executives made a trip through parts of Great Britain, Scandinavia and Europe. This trip was of an exploratory nature, looking for new ideas in steelmaking and steel processing as well as some first hand information about new processes and installations that have been put into operation or are being contemplated in the various countries. In five and one-half weeks, eight countries and approximately forty plants were visited. All of the people contacted in all of the countries were extremely hospitable, friendly and most generous in sharing their knowledge and ideas.

At the outset of such a trip as this, several questions would naturally come to mind, such as:

1. Is there not an excess of manpower in these countries? What interest, then, would there be in such things as automation, productivity per manhour, etc.?
2. Are these countries interested in quality and production to the extent that we in the United States are?
3. How much modern equipment would we see?
4. With such a difference in raw materials, how could the processes be compared?

Such doubts as these can be quickly dispelled for all of us. In most of the countries of Europe, there is not an excess of manpower. In some of the countries, there is an acute shortage of skilled labor. There is a decided interest in automation, productivity per manhour and costs. There is, if anything, an over-emphasis on production, and some very good efforts are being made to maintain or improve quality. In every one of the steel plants visited, they had either recently completed a sizable expansion of steelmaking or processing facilities, or were about to embark upon such an expansion. Their methodical approach in making these expansions was most interesting, quite a shock and very thought-provoking in comparison with our rather typical American attitude of "full speed ahead—meet the trouble when you come to it."

Some of the problems faced by the European steelmen make ours seem rather small. The approach to the problems in practically all of the places visited was on a very scientific, detailed basis. Each plant was thoroughly covered by technical personnel evaluating every small facet of the operation. Although this can become cumbersome if carried to an extreme, it is undoubtedly a great help in many ways.

Regarding the question of the difference in raw materials, it was found that there was much for us to learn despite variances in raw materials or their availability. In fact, we here have no assurance that we will not be faced with many of the same problems tomorrow that the people of Europe are facing today.

We had the pleasure of starting our survey with a week's tour of a few steel plants in Sweden. Those visited were at Avesta, Domnarvet, Sandviken and Sodofors. Avesta is currently undergoing an extensive

Figure 1 — The Hättingen mill is a 4-high, 165-in. mill.

expansion program, and the thinking there, as well as in the other Swedish plants, is very progressive. From the technical standpoint, two things were particularly outstanding about this plant: (1) their research and metallurgical laboratory—a very modern and completely equipped installation which, with a total plant population of 5000, employs approximately 200 technically trained people, and (2) their hot topping operation which involves forming the hot top in the molds after they are set in the pits.

Figure 2 — A vertical edging mill is used at Hättingen.

In Domnarvet we had the privilege of talking with Professor Bo Kalling, who is affectionately regarded as the "Father of the Swedish Steel Industry." He has developed a number of very interesting steel processes, perhaps with the limitations of the natural resources of Sweden and its geographical location in mind. The Kal Do, "H" iron, and the sponge iron processes are among these new developments. We were naturally quite interested in each, and during our visit had an opportunity to see a heat made in the Kal-Do convertor as well as the sponge iron process and its attendant pelletizing.

The Kal-Do process has been very capably described in a number of articles, one of the more recent being in *Blast Furnace and Steel Plant*, February, 1957. The operation seemed to be quite adequate to the demands made of it. The relative merits of this process versus the Linz process should be weighed according to the individual company's circumstances.

The sponge iron and the "H" iron processes also must fall into the category of the individual company's economic position. The apparent reason for the development of these processes in Sweden was the lack of good coking coal and the resultant dependency on an outside supplier with the accompanying hazards and expense.

The blast furnaces at Domnarvet were designed and built by their own people, and were producing a very creditable tonnage with 100 per cent sinter burden and 1500 F preheated blast. All of their coke is imported, and their coke rate is sufficiently low to make the operation economically sound.

Our visit to Denmark took us to the Danish Steel Works at Frederiksvaerk. This is a small, cold metal, bottom-pour shop operating along lines which Lukens had helped them to start. They have since made excellent progress on their own. In their open hearth they are operating three basic furnaces tapping 132-ton heats. They charge the furnaces at the rate of 45 tons per hr. Firing rates are high and heat time excellent. High alumina brick is employed in the checkers, and forced draft in the stack to assist furnace operation. Water capping of the ingots is applied. The resulting bottom-poured ingots are charged in the pits at 2000 F or above. They are doing an outstanding job with the facilities at hand. We are certain that this mill will continue to hold an interest for us at Lukens for many years to come.

In Germany, where we were to spend one of the busiest weeks that we had ever known, we were met by our friend Wilhelm Hilterhaus, who predicted that we would not be satisfied with the short time that we could spend there, and he was absolutely correct.

For us of Lukens, the mill at Hättingen was a revelation and an inspiration. The operation of this mill was along the same general lines as our 206-in. mill—i.e., direct rolling of bottom-poured slab type ingots to plate. It is a jobbing mill filling many miscellaneous types of orders, but here, as with the rest of the European plants, hull plate is the prime tonnage item. There are a number of features about the mill at Hättingen that have not as yet appeared in United States papers, and will undoubtedly be of interest.

The Hättingen mill (Figure 1), put into operation about June, 1956, is a 4-high 165-in. mill with twin

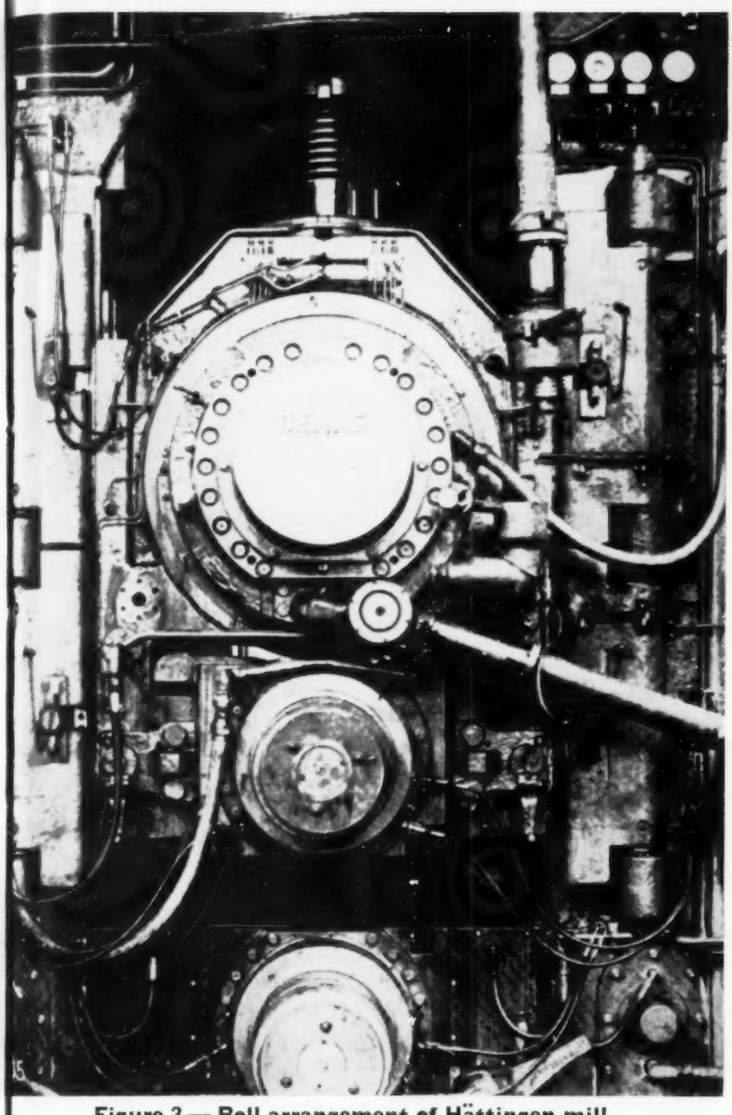


Figure 3 — Roll arrangement of Hättingen mill.

motor drive. Since it has been in operation, two other mills—almost direct copies—have been installed: one at Linz, Austria, and the other at Milan, Italy. The plate rolling practices are quite similar to those employed in our 206-in. mill, except that they use a detached vertical edger mill, in addition to the four-high stand (Figure 2). They roll direct from ingot to plate in ingot sizes ranging from 1800 to 90,000 lb, a minimum plate thickness of $\frac{5}{16}$ in. (Figure 3). The mill has a 72 x 157-in. backing roll. The work roll is 39 in. diam x 165 in., of the-indefinite chill type. The backing roll has oil-film bearings; the working roll has roller bearings. The maximum mill opening is $39\frac{3}{8}$ in. The mill drive motors are in the open with air circulation from underneath.

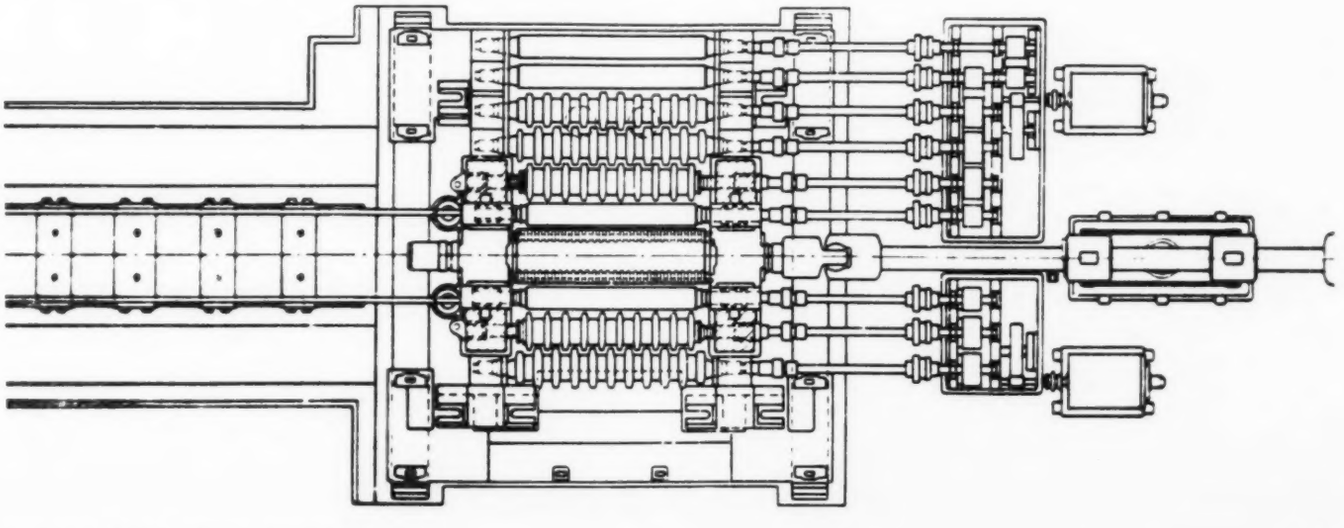
Mercury arc rectifiers for supplying the main drive motors are employed instead of motor-generator sets. This application of mercury arc rectifiers was found to be rather general throughout Germany on both slabbing and plate mills. The rectifiers are of the single-anode tank type. Naturally, the elimination of the motor-generator set with its associated equipment allows a mill installation without the usual motor room, and offers numerous operating and maintenance advantages.

The central control station, in which the production flow was co-ordinated, is located in the heating department. At this one point, all of the paper work that is generated in the course of operating a mill is controlled and held to a minimum. All providing is performed, the charging and drawing of pits and continuous furnace is controlled. The rolling information is relayed to the mill via closed circuit television which we found to be excellent in contrast and clarity. The shearing information is also relayed to the shears. In turn, the necessary tabulation of rolling results, shearing, and inspection performance is all done in this area. Pneumatic tubes are used to convey written messages to and from such locations as the shears, open hearth, mill pits, central production control, etc.

The feed roll design (Figure 4) on the Hättingen mill is very unique. It was designed with the idea of permitting the rolling of 20-in. long pieces. This requires a feed roll inside the mill housing, another through the mill housing and the remaining feed rolls outside the housing in the more conventional fashion. On the mill being built at Linz, the pass line will be adjustable by raising or lowering the feed rolls hydraulically. This feature was noted in operation on a mill in England, and appeared to be quite satisfactory.

The guide arrangement (Figure 5) on the German plate mills generally—and the Hättingen mill was no

Figure 4—Feed roll arrangement on Hättingen mill is unique.



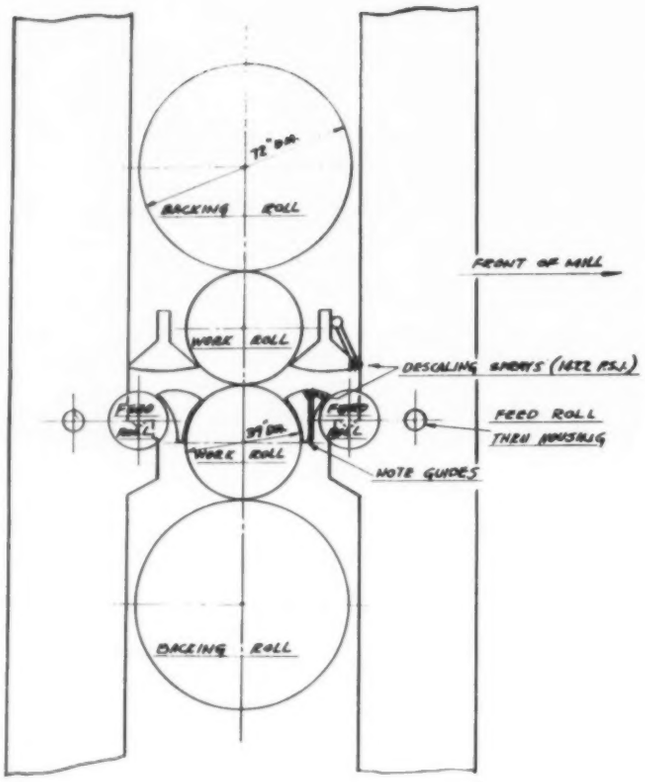


Figure 5 — Descaling water goes through slots in guides.

exception—calls for a solid cast steel guide and guide bar combination with 3-in. slots to permit the scale to fall through. However, on this mill the descaling spray headers (both top and bottom) are attached to these slotted steel guides and the descaling water at a pressure of 1422 psi comes through the slots. These guides fit into the work roll chucks and were changed with the work rolls. The swing joints are on the side of the mill where plates being rolled cannot hit them. The cleaning action of these sprays seemed to be quite good. The joints were very tight and no leakage was noted through the nozzles.

The straightening rolls (Figure 6) were found to be a very interesting piece of equipment. The work rolls are alined six on bottom and seven on top. With the exception of the end rolls on the top line, the rolls are $10^{15}/_{64}$ in. in diam. The diameter of the adjustable end rolls is $11^{27}/_{64}$ in.; the center distance is $12^{13}/_{64}$ in. The work rolls are water-cooled internally and have a hardness of 80 sceleroscope. The backing rolls are $10^{5}/_{8}$ in. diam, and are broadly spiralled on about 2-in. spacing. It is equipped with a quick, high-lift arrangement employing eccentrics which permit the top train to be lifted almost instantaneously to a maximum opening of 12 in. It was said that if a crane of sufficient capacity were available, the work rolls could be changed in one hour.

The plate cooling table (Figure 7) at Hättingen is of a new and unique design. This table consists of parallel rows of disk-type rolls. Each eight foot section of roll is made up of disks spaced on a shaft supported at each end. These supports are anti-friction bearings applied to the end disk of each section. Between each disk is a steel pipe spacer with an air space between it and the central shaft. Each section of roll is flexibly coupled to the next section, the couplings are arranged to allow for expansion and contraction. The efficiency of this design was reported to be 30 per cent greater than the standard grid design.

The shear line servicing the mill is somewhat similar to that at Homestead, the big difference being in the scrap handling procedures. All of the scrap generated by the Hättingen shear line is handled by an elaborate underground belt conveyor system. The scrap is taken to a central scrap shear, and then loaded semi-automatically into open hearth charging pans.

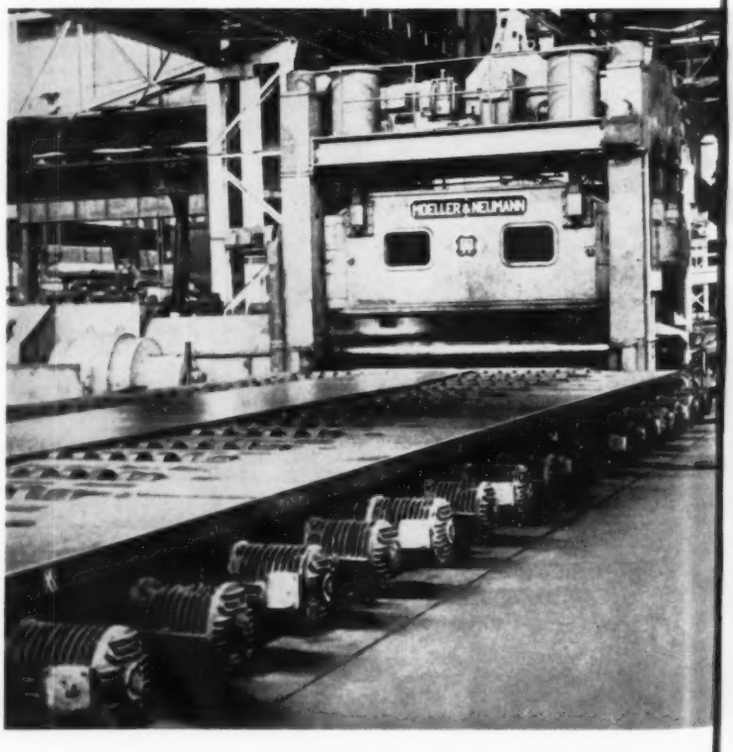
The most interesting feature of the heating department is the continuous pusher-type furnace (Figure 8) that is used to heat ingots up to 10,000 lb (16 in. thick). There were no indications of a cold side on the ingot during the course of rolling. This furnace has a production rate of 44 tons per hr, as compared to 9 tons per hr from their soaking pits. They selected this furnace because of: (1) its heating efficiency on small ingots, and (2) the difficulty of handling small ingots with the large stiff-leg crane.

This long discussion of the mill at Hättingen should leave little doubt that the thorough job of planning, engineering and operation represented by this installation was most impressive.

A number of metallic recuperators were observed on soaking pit furnaces and on hot blast cupolas. The maximum air preheat is in the range of 1000 F, and is used in conjunction with a mixed gas of 130 to 150 Btu per cu ft. No service figures were available to us since most of them had never been replaced.

The interest displayed by most of the companies that we visited in reducing manpower requirements was surprising. There were obvious manpower problems brought on by the war. In most of the new mills, great care is being exercised to keep manpower requirements to a minimum.

Figure 6 — Straightening rolls at Hättingen are alined six on bottom and seven on top.



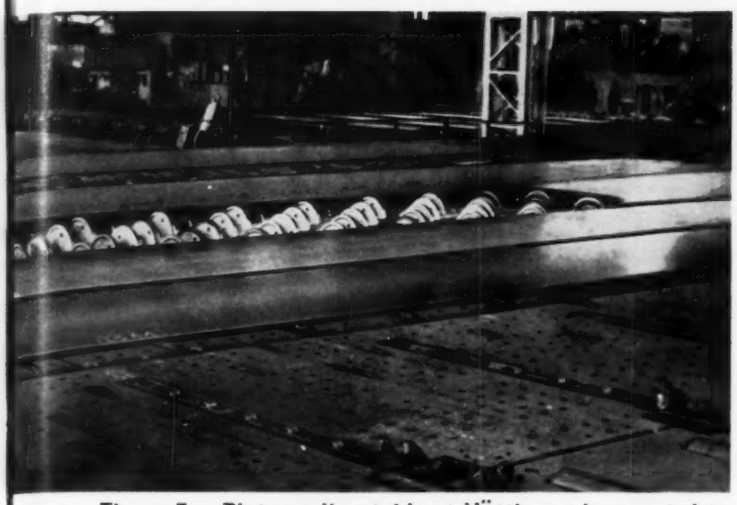


Figure 7 — Plate cooling table at Hättingen is reported to be 30 per cent more efficient.

The Royal Dutch Steel plant in Holland is quite a remarkable plant in that they are operating very efficiently in a country that has no natural resources upon which to draw. Through the ingenuity and skill of the people working there, they have made it a going concern. The operator of the slabbing mill on the day we visited had never seen the inside of a steel mill a year prior to that day—and he was doing a reasonably adequate job. This company is in the process of installing a new desiliconizing plant and a large oxygen plant.

Our visit to Linz, Austria, was very beneficial and inspiring. The L-D process has already received a great deal of publicity, and there is little need to go into detail about it here. Let it suffice to say that we were quite impressed by the operation and our conversations with Dr. Trenkler and Mr. Schaden. Since a relatively large number of companies in Europe are committed to some form of oxygen blowing for steel production, there is a definite trend toward company-owned oxygen plants. Most of these seemed to be of the Linde-Frankel low pressure type.

In our tour of a few plants in Great Britain, we found activity and ingenuity comparable to that witnessed elsewhere. We were particularly interested in the oxygen roof jets in use at the Steel Company of South Wales. The sintering plant in this mill was quite modern, as was the strip mill.

The layout and operation of the new open hearth plant at Dorman Long in Middlesbrough, England, is excellent. Here, as in many European plants, an active mixer was employed to reduce phosphorous and silicon in their pig iron, and to melt up low grade pit scrap. A central building houses the water pumps, air compressors and transformers for open hearth services, centralizing these activities in one location. In the same building, lime, limestone, spar and dolomite are dumped by means of a car dumper into hoppers, the necessary crushing is performed, and these materials are then conveyed to the open hearth by covered conveyors from which they are discharged into charging pans on trucks. Loam, fire clay and chrome ore are also mixed in mullers at this central location, which was installed in an attempt to consolidate all open hearth odd jobs and develop a work load for fewer people.

As a result of our findings on this trip, the current expansion program at Lukens will have a number of features that possibly may have been overlooked had the trip not been made.

In summary, we might emphasize the following points:

1. The people of Europe are doing an excellent job despite the handicaps they face in available raw materials, transportation systems and manpower. After seeing them operate, we can certainly appreciate all the more our abundance of oil, natural gas and our 40-ft plus broad gage cars.
2. There is a great expansion of steel processing facilities taking place in Europe. The planning for this expansion has been very thorough, and employs many new engineering and production techniques.
3. There is much to be learned from the developments that are taking place in Europe, such as the Kal-Do and L-D processes, blast furnace modifications, excellent industrial television and other communication systems, mill design variations, all primarily resulting from a great emphasis on research.
4. We cannot afford to be complacent about our present state of development in any way. We are faced with some good, friendly competition that makes our task doubly interesting.
5. Of all the handicaps under which the European plants generally operate, it is my opinion that the greatest one is self imposed—that is in the realm of human relations. It was obvious to all that a definite line of demarcation exists between supervision and labor in most of the mills visited. We personally are firm believers that nothing improves quality and production more than good teamwork. There was little evidence of "team spirit" in most of the plants visited. ▲

Figure 8 — Continuous heating furnace is of pusher type.

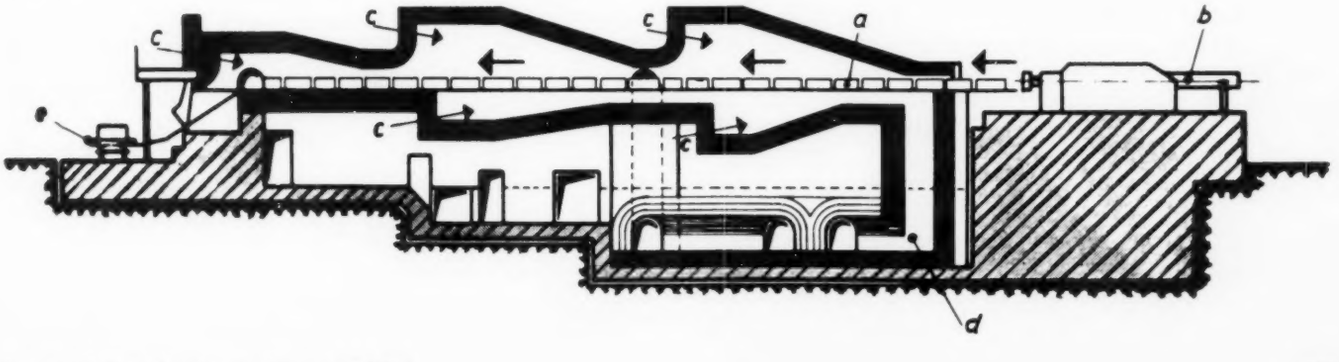


Figure 1 — The general layout of an ore bridge is pretty well standardized.

structural design problems and recommended practice for Ore Bridges and Unloaders

by William B. McLean, Structural Engineer
Engineering Works Div., Dravo Corp., Pittsburgh, Pa.

. . . . ore bridge design requires extensive experience and judgment by the designer . . . few structures are subjected to such severe fatigue loadings and few structures have to work under such continuous and difficult conditions . . . . a steel industry specification covering ore bridges would be helpful and valuable to the user . . . .

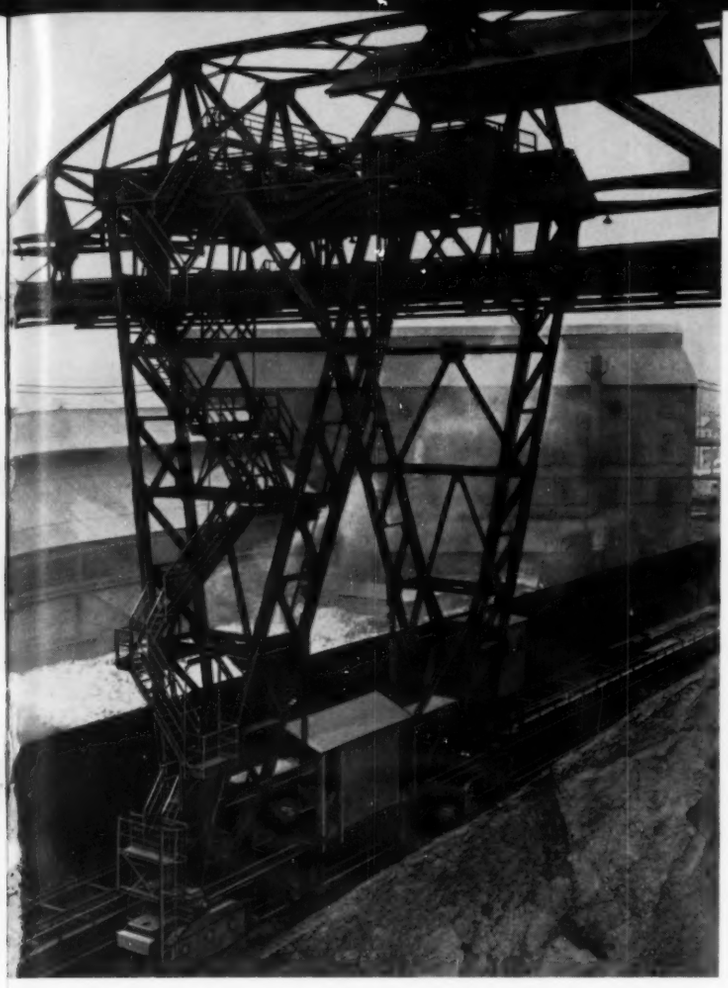


Figure 2 — The pier leg is normally of the "V" type and can rock slightly on a narrow base.

Figure 3 — The shear leg carries the span on a ball and socket joint in order to permit skewing and rocking.

THE following paper covers structural problems and recommended practices in the design of ore bridges. In general the comments apply equally well to unloaders since conditions and service are very similar for these two types of structures.

The origin of ore bridges and unloaders can probably be traced to the early 1880's when an overhead cableway system was used to carry hand-filled buckets from the hold of lake boats to a storage pile. About this time the spread of the bessemer process was leading to greatly increased steel production in this country and the need for handling large quantities of ore encouraged the development of the machine which has now become our modern ore bridge. It was not many years from that first beginning until rigid runways were adopted, the self-filling grab bucket developed, and the electrically-powered man trolley introduced.

Ore bridges have come through considerable evolution since those early days, with various types of trussing and supports having been used. Today, the general layout of an ore bridge is pretty well standardized (Figure 1). It usually consists of a rigid truss span supported by a pier leg near one end and a shear leg near the other, with provision inherent in the structure to permit the span to skew a few degrees either way from normal. The pier leg is normally of the V type (Figure 2), able to rock slightly on its narrow base to accommodate span deflections and supporting the span on four sliding plates with a centering king pin to allow for the skewing. The shear leg (Figure 3) is in effect a single plane bent carrying the span on a ball and socket joint. This permits both the skewing motion and the rocking of the leg due to changes in span length. The trolley runway is now generally at bottom chord level supported by open cross frames. To this is added, if conditions require, a lift apron, a receiving hopper, or possibly a portal under the pier leg.

It should be emphasized that these structures are subject to extremely severe service. When operating on duty cycle service with the trolley shuttling back and forth at full speed, they are subject to a full live load stress cycle every 30 to 60 sec and a return trip with empty bucket of about 80 per cent of this load again. Most ore bridges work a pretty good percentage of the time and can easily build up several million stress cycles in the life of the structure. This is a more severe condition than confronts almost any other type of structure. Railroad bridges in areas of very heavy traffic are perhaps their only rival for withstanding a continuous pounding.

Since ore bridges are in reality large moving machines, they are subject to vibration and racking forces that are not present in the usual structure of this size. Also they are often in a highly corrosive atmosphere that makes maintenance extra difficult. In many cases plant operations depend on them for keeping the furnaces supplied with ore, and a shutdown for repairs is most embarrassing. In view of all this, careful consideration must be given to their proper design to insure long life and continued service.

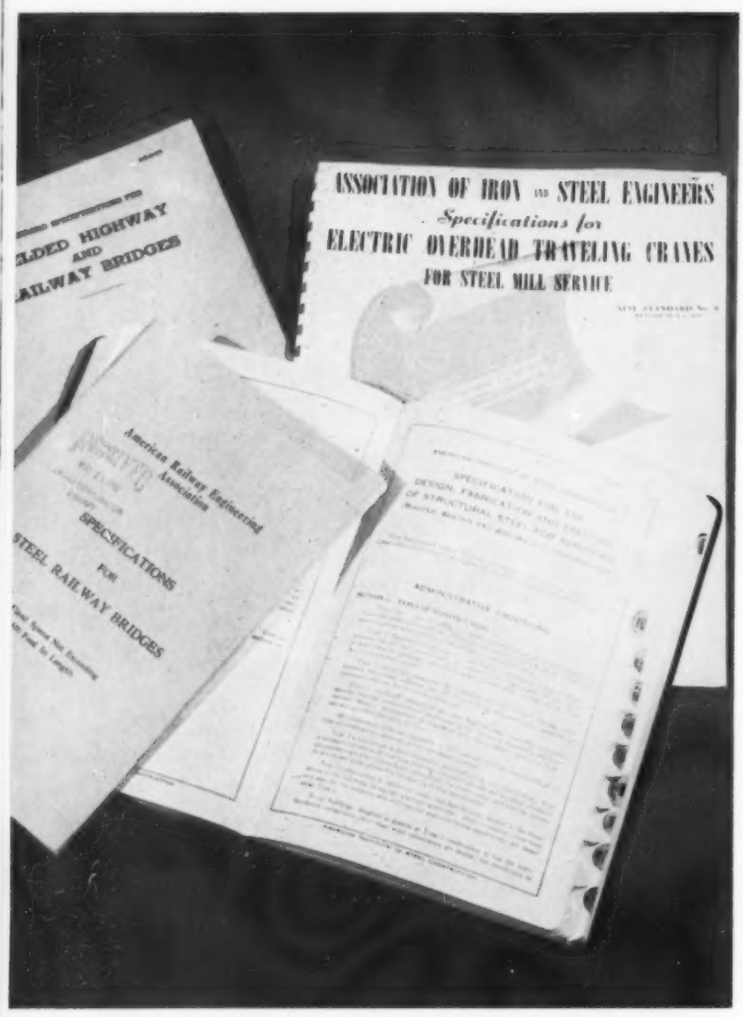


Figure 4 — Portions of four standard specifications are often used for ore bridge design.

The factors to be considered in the structural design can be grouped as follows:

1. Loading.
2. Allowable unit stresses.
3. Type of construction—i.e., riveted or welded.
4. Features of design and details.
5. Materials of construction.
6. Fatigue considerations.
7. Special considerations—brittle fracture and laminations.
8. Workmanship.

To some extent these factors are covered by existing standard specifications, but there is no one specification which covers all of the requirements of an ore bridge.

There are four standard specifications which are sometimes used for the design of an ore bridge. See Figure 4. These are: (1) the AISE Standard No. 6—Specifications for Electric Overhead Traveling Cranes for Steel Mill Service; (2) the AREA Specifications for Steel Railway Bridges; (3) the AISC Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings; and (4) the AWS Specifications for Welded Highway and Railroad Bridges.

Let us consider these specifications briefly and see how they apply to ore bridges.

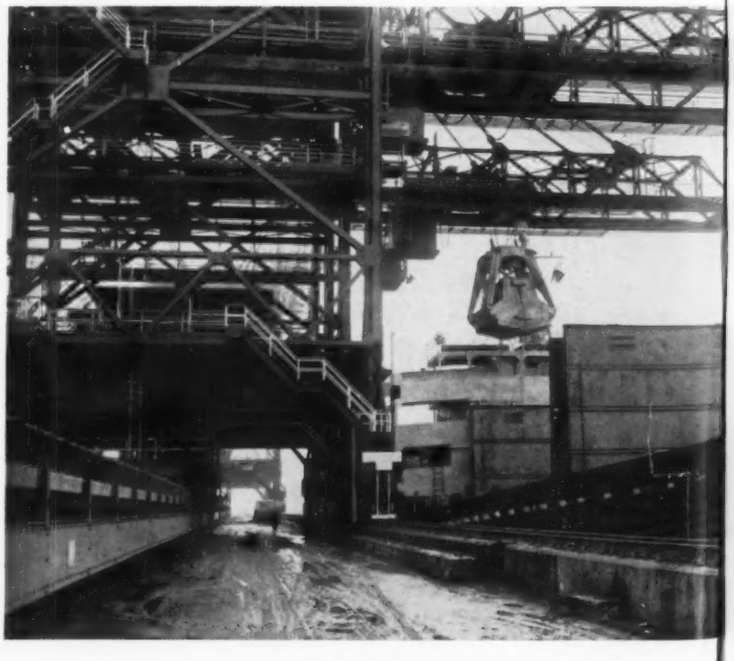
The AISE Standard No. 6 is an excellent specification for its intended purpose. This is primarily the design of welded, heavy duty, mill type, overhead traveling cranes, particularly of the box girder type, but applicable to other types. The opening paragraph states that all cranes for special service such as charging, pit, stripper, ladle, gantry cranes, or *ore bridges*, etc., shall *so far as possible* comply with these specifications. Thus the writers recognized that the design of an ore bridge would involve additional conditions and perhaps different factors. Although these specifications can be and sometimes are used by the purchaser for an ore bridge, present day general design practice differs from them in the following respects:

1. Ore bridge spans are normally of riveted construction because of fatigue conditions.
2. Assumed impact percentages may differ from those specified in Standard No. 6.
3. Lateral forces are generally assumed less than in these specifications. This reflects the fact that a bridge travels much more slowly than a crane.
4. Skewing forces are of course special to ore bridges and are not covered in any standard specification.
5. Greater values for wind forces are usually assumed for ore bridges.

The AREA specification for Steel Railway Bridges is a top grade structural specification frequently cited by purchasers of ore bridges who want a product of high quality. It is quite applicable to ore bridges except for such factors as impact percentages, wind loadings, lateral and longitudinal forces, skewing forces and fatigue considerations for welded construction.

The AISC Specifications for Structural Steel are the most lenient of our usual structural specifications. They occasionally are used for ore bridges with the special provision of reducing the allowable unit stress from 20,000 to 18,000 psi. This specification does not result in as substantial a structure as is advisable for ore bridges and its use in this field is more often confined to rope type unloaders.

Figure 5 — Live loadings on a bridge are generally easily determined.



The AWS Standard Specifications for Welded Highway and Railway Bridges are intended as a supplement to the structural specifications. They apply only to the welding or parts affected by the welding. Of particular interest is the table of required sectional area for members connected by fillet welds and subject to two million stress cycles. This results in surprisingly low unit stresses for such members and will be discussed in more detail later.

Getting back to design problems, consider the factors listed above more fully.

1. *Loadings*—Loadings to be considered are dead load, live load, impact, lateral or longitudinal forces caused by movement of the trolley or bridge, wind loads, and skewing forces, and occasionally earthquake forces.

Dead load is no great problem. Past records form a basis for a preliminary dead load assumption. The structure can then be designed, the actual dead load computed, and any necessary corrections made for the revised dead load.

Live load is also easy since it consists of the trolley and its suspended load, all of which can be readily computed. See Figure 5. Of course, after the structure has been in use a couple of years, the customer may find ways to increase the capacity of the bucket and pick a heavier load, and a few years later he may ask for revisions to the trolley to further increase its capacity. Nevertheless, this is not in the same category with highway or railroad bridges where the size and weight of future live loads is pretty much a matter of conjecture.

Impact, lateral and longitudinal loads are of a more indefinite nature. The most authoritative information on this subject that we know of are the tests made at Lehigh University in the 1930's by I. E. Madsen. These were the basis of the 1942 revisions to the AISE specifications. These tests were made on mill cranes, three being of the box girder type and one a 5-ton I-beam crane. Briefly, it was found that lateral loads were about 10 per cent of the vertical forces. For a 50 per cent drive this amounts to about 20 per cent friction on the driven wheels. Impact due to suddenly lifting the load from the floor varied from 9 to 33 per cent of the lifted load. Tests were also made by running the crane over wooden wedges giving $\frac{9}{16}$-in. drop and these showed impacts of 31 to 51 per cent of the total load acting. This drop is of course much more than would be expected on modern runways. A report by I. E. Madsen on these tests is published in the November, 1941 issue of the Iron and Steel Engineer.

AISE Standard No. 6 calls for vertical impact to be 50 per cent of the maximum working load for grab buckets and magnet cranes or for other cranes $\frac{1}{2}$ per cent of the maximum working load for each foot per minute of hoisting speed. Since ore bridges hoist from 200 to 300 fpm, this would be 100 to 150 per cent of the bucket and ore. In terms of total trolley weight for man trolleys, this would be about 25 to 40 per cent of the total trolley weight. Other standard specifications give no indication of what impact percentages should be used for ore bridges.

It is a fairly common practice at the present time to use the following percentages of total trolley weight as impact:

For runway stringers and crossframes—40 per cent.
For trusses and legs—25 per cent.

Also, wherever it might govern, an impact of 10 per cent of total dead plus live load is used to allow for the effect of traveling the bridge down the runway. This usually governs the design of the legs and trucks. This is somewat in line with railroad bridge practice where the impact percentage is reduced as the loaded length increases. This reflects the effect of the greater resilience of a longer length.

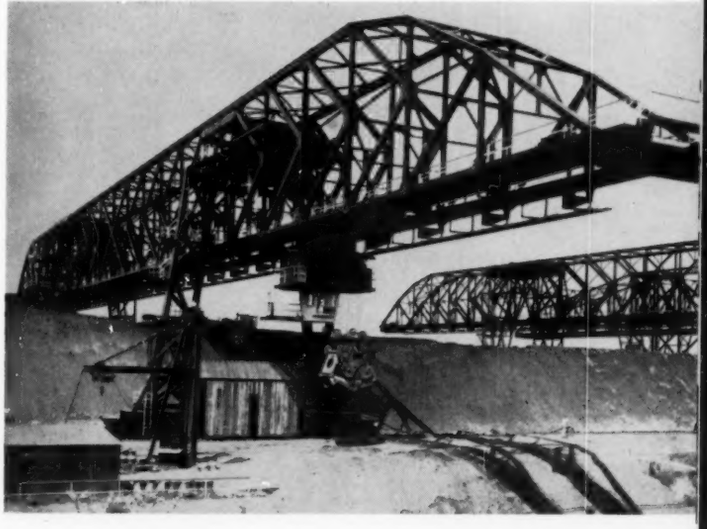
Since the trolley is usually accelerated or decelerated at about 3 fps, a longitudinal force of 10 per cent of trolley weight is used. A lateral force due to trolley travel of 10 per cent of wheel loads is quite customary. This is an arbitrary assumption and may well be on the high side. It has a considerable influence on the design of the runway stringers, introducing a lateral moment in the top flange. The travel of the bridge itself is quite slow—75 to 100 fpm—and lateral or longitudinal force from this action is arbitrarily assumed to be 5 per cent of dead plus live load. Usually lateral and longitudinal loads are not combined, although some owners do require such combinations.

This matter of impact and lateral and longitudinal forces on ore bridges is a field in which further investigation would be beneficial.

Wind loads for ore bridges are divided into two classes—operating and nonoperating. Operating wind for structural design is usually assumed at 10 lb per sq ft (about 50 mphr) and is combined with maximum live load and impact. Nonoperating wind is usually assumed at 30 lb per sq ft (about 82 mphr) and is combined with dead load plus the empty trolley in the parked position. Under this latter condition a 25 per cent increase in unit stress is usually allowed. It also is customary to check the structure for stability under a 45 lb per sq ft wind (about 106 mphr). In this case a stress of 80 per cent of the yield point is allowed. Occasionally structures in the hurricane zone are made stable or provided with tie downs to resist a 90 lb per sq ft wind (150 mphr).

The indefinite feature about wind loads is the area to which the assumed forces should be applied. In a span

Figure 6 — More information on wind loadings of ore bridges would be quite desirable.



composed of two parallel trusses, obviously the first truss gets all the wind load, but what about the lee truss? For many years it was customary to use 1½ times the vertical projection of the span. It is now becoming increasingly common to use two times the projected area. This change probably is the result of wind tunnel tests now becoming available. The earliest such tests were made by the Aerodynamic Institute at Gottingen, Germany in 1927. Wind tunnel tests were made on small scale cardboard models using varying types of trusses, spacing, wind directions, etc. These showed that for ordinary truss spans, the factor of 1½ was not sufficient, the correct factor varying with spacing, type of truss, etc. They also showed that a quartering wind will give higher forces than a direct level wind, and that considerable endwise forces can be set up.

A more recent series of tests made at the Wright Brothers Wind Tunnel at M.I.T. has been reported by Mr. John M. Biggs in an article titled "Wind Loads on Truss Bridges" and published in ASCE Separate No. 201, July, 1953. Here again models were tested with varying spacings, etc. These tests seem to indicate that for proportions that are usual for ore bridges a factor of 1¾ would be reasonable. In figuring wind areas, of course, any solid areas such as machinery houses, control houses, etc. are taken at only one time their area. The greatest uncertainty is the area exposed to end wind (Figure 6). If the wind is slightly quartering this area can become considerable, since practically all of the cross frames are exposed. A common practice is to take the end wind area as one half the assumed side wind area. This may be on the light side.

The effective wind area is another field where further research should be valuable. Hardly a year goes by without one or two ore bridges in this country being blown down. Many of these are older bridges without some of the modern safe guards, and they usually go down in freak storms of short duration; nevertheless, they do go down, and careful precautions are certainly justified.

Skewing forces are peculiar to ore bridges and standard specifications give no clue as to what to use. These forces result from friction on the sliding plates on top of the pier leg. In modern practice these are polished bronze plates immersed in a reservoir of oil and sliding on smoothly machined steel plates. Unless maintenance is neglected, the friction factor should be

Figure 7 — These commonly used formulae for allowable stresses in welded structures were developed by the American Welding Society.

Loading Producing Maximum Stress		Base Metal in Axially-Stressed Members Adjacent to Splices or Connected by Fillet or Plug Welds[1]		
Ordinarily Applies to Railway Bridges	Ordinarily Applies to Highway Bridges	Form. No.	Max. Stress	Required Sectional Area
Short Critical Loading (100 feet or less of loaded single track.)		1	Tension	$A = \frac{\text{Max.} - \frac{3}{8}\text{ Min.}}{7500}$ but $\leq$ Max. 10,000 $\leq \frac{\text{Min.} + \frac{1}{3}\text{ Min.}}{p}$
		2	Compression	$A = \frac{\text{Max.} - \frac{2}{3}\text{ Min.}}{7500}$ but $\leq \frac{\text{Max.} - \frac{1}{2}\text{ Min.}}{p}$ $\leq \frac{\text{Max.}}{p}$
Longer Critical Loading. (More than 100 feet of loaded single track or any length of two or more tracks.) Use loading directly above if greater area is required thereby.	Short Critical Loading. (Not more than two panels or 60 feet of loaded single lane.)	3	Tension	$A = \frac{\text{Max.} - \frac{2}{3}\text{ Min.}}{10,500}$ but $\leq \frac{\text{Max.}}{14,000}$ $\leq \frac{\text{Min.} + \frac{1}{2}\text{ Min.}}{p}$
		4	Compression	$A = \frac{\text{Max.} - \frac{2}{3}\text{ Min.}}{10,500}$ but $\leq \frac{\text{Max.} - \frac{1}{2}\text{ Min.}}{p}$ $\leq \frac{\text{Max.}}{p}$
	Longer Critical Loading. (More than two panels or 60 feet of loaded single lane or not more than two panels or 60 feet of loaded two lanes.) Use loading directly above if greater area is required thereby.	5	Tension	$A = \frac{\text{Max.} - \frac{2}{3}\text{ Min.}}{15,000}$ but $\leq \frac{\text{Max.}}{18,000}$ $\leq \frac{\text{Min.} + \frac{1}{3}\text{ Min.}}{p}$
		6	Compression	$A = \frac{\text{Max.} - \frac{2}{3}\text{ Min.}}{15,000}$ but $\leq \frac{\text{Max.} - \frac{1}{2}\text{ Min.}}{p}$ $\leq \frac{\text{Max.}}{p}$
	Loading in more than two panels or 60 feet of two or more lanes	Basic Unit Stresses (See Par. 207.)		

A = Required Effective Area; p = allowable unit compressive stress as prescribed by the general specifications for the type of member involved; the capacity of a full butt weld in compression being treated as identical with that of the connected material "Max." and "Min." refer to total stresses. "Max." is the numerically greater stress

Required Effective Weld Areas in All Members and Parts

Form. No.	Type of Weld	Max. Stress	Required Weld Area	Form. No.	Type of Weld[2]	Max. Stress	Required Weld Area
7	Butt	Tension	$A = \frac{\text{Max.} - \frac{1}{3}\text{ Min.}}{13,500}$ but $\leq \frac{\text{Max.}}{18,000}$	9	Butt	Shear	$A = \frac{\text{Max.} - \frac{1}{3}\text{ Min.}}{9000}$ but $\leq \frac{\text{Max.}}{13,000}$
8	Butt	Compression	$A = \frac{\text{Max.} - \text{Min.}}{18,000}$ but $\leq \frac{\text{Max}}{p}$	10	Fillet or Plug	Shear	$A = \frac{\text{Max.} - \frac{1}{3}\text{ Min.}}{7200}$ but $\leq \frac{\text{Max.}}{12,400}$
11	Butt	Tension	$A = \frac{\text{Max.} - \frac{1}{2}\text{ Min.}}{15,000}$ but $\leq \frac{\text{Max.}}{18,000}$	13	Butt	Shear	$A = \frac{\text{Max.} - \frac{1}{3}\text{ Min.}}{10,000}$ but $\leq \frac{\text{Max.}}{13,000}$
12	Butt	Compression	$A = \frac{\text{Max.} - \frac{5}{9}\text{ Min.}}{18,000}$ but $\leq \frac{\text{Max}}{p}$	14	Fillet or Plug	Shear	$A = \frac{\text{Max.} - \frac{1}{3}\text{ Min.}}{10,000}$ but $\leq \frac{\text{Max.}}{12,400}$
15	Butt	Tension	$A = \frac{\text{Max.} - \frac{1}{3}\text{ Min.}}{18,000}$ but $\leq \frac{\text{Max.}}{18,000}$	17	Butt	Shear	$A = \frac{\text{Max.} - \frac{1}{3}\text{ Min.}}{12,000}$ but $\leq \frac{\text{Max.}}{13,000}$
16	Butt	Compression	$A = \frac{\text{Max.} - \frac{1}{3}\text{ Min.}}{18,000}$ but $\leq \frac{\text{Max.}}{p}$	18	Fillet or Plug	Shear	$A = \frac{\text{Max.} - \frac{1}{3}\text{ Min.}}{12,000}$ but $\leq \frac{\text{Max.}}{12,400}$

Basic Unit Stresses. (See Par. 207.)

[1] See Par. 212(d) for restriction on use of plug and slot welds.

[2] See Par. 212(b) for enhanced allowable stresses for butt welds made smooth and flush.

low. This force has considerable effect on the adjacent truss and pier leg members, and puts a twist on the pier leg as a whole. Beyond this its effect is minor. This force is usually assumed as a 10 per cent friction, which is probably well on the safe side for normal operations, but if the bridge has been standing idle for some time, an increased break away force may be expected.

2. *Allowable unit stresses*—The basic allowable unit stress for the design of ore bridges is pretty well standardized at 18,000 psi on net area in tension, with corresponding values for other types of stress.

When the stress fluctuations are pronounced enough or frequent enough to put the structure in a fatigue range, care must be exercised to use a proper reduction in the allowable unit stress. The AREA specifications and the AISE Standard No. 6 require that when a member is subject to reversal of stress, 50 per cent of the reversed stress shall be added to the maximum stress for design of the member and 100 per cent for the design of the joint. This in effect reduces the allowable unit stress for such members.

The AISC specifications are more lenient and have a less severe clause governing such reversals which increases the "connected material" but not necessarily the main body of a member. In none of these (except the AWS specification) is any increase required in the area of a member where the stress merely fluctuates but does not pass through zero during travel of the live load. The AWS specification (Figure 7) has a very comprehensive set of formulas for required area for members connected by fillet welds. These are based on a number of series of fatigue tests conducted under the auspices of the Welding Research Council of the Engineering Foundation. They are set up for highway or railway bridges and need some interpretation when applied to ore bridges. For structures in the fatigue range of two million cycles (which includes ore bridges) these formulas are quite severe. They result in the following allowable unit stresses:

1. Where stress varies from half maximum to full maximum—11,250 psi.
2. Where stress varies from zero to maximum 7500 psi.
3. For full reversal—4500 psi.

One question which needs clarification in applying these formulas to ore bridges is whether to include the occasional loads such as lateral or wind loads which do not really contribute to fatigue but do effect the peak stresses. They are sometimes included in the maximum but not the minimum stresses.

This problem of fatigue is a very serious and baffling one and will be discussed more fully later.

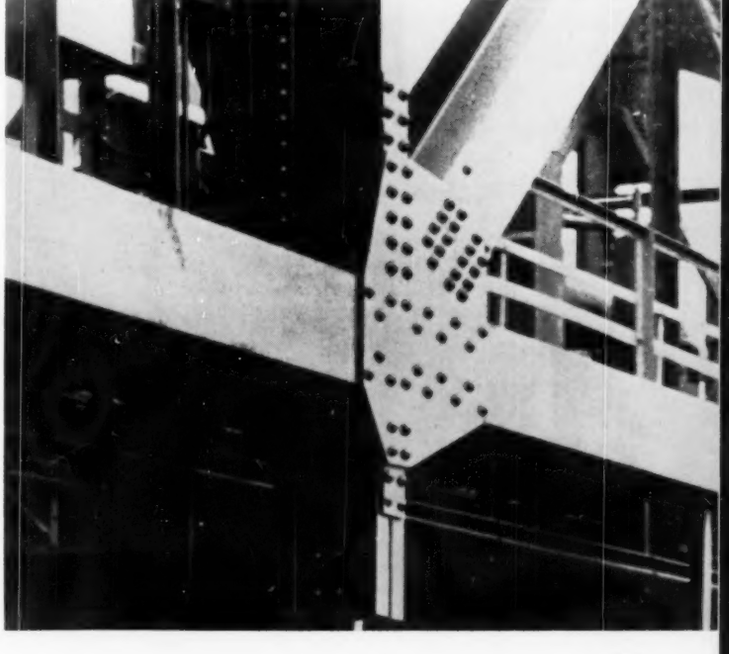
3. *Type of construction*—One of the first questions to be considered in the design of a steel structure is whether it shall be riveted or welded (Figure 8). The fatigue unit stresses for welded members just mentioned give a quick answer so far as the bridge span is concerned. Here the fluctuation of stress due to passage of the live load would make an all-welded span definitely uneconomical, although perhaps certain parts or details could be welded if proper precautions were taken. It is our guess that the present disparity between riveted and welded allowable stresses in such

Figure 8 — Both riveted and welded construction are used in ore bridges.

cases gradually will be reduced as time goes on. As we learn more about welded work and as service records give a better measure of what it will withstand, these surprising low allowable stresses will be increased. Also, as we learn more about the damaging effect of fatigue, we may see a stiffening of requirements for riveted work for structures of this class of service.

A few bridges having welded cross frames have been built in recent years. These cross frames are subject to even more severe fatigue than the span trusses, and provision must be made against it. They are of lighter members than the trusses, and because a number of identical cross frames are fabricated, certain alleviating measures can be taken such as jigging and butt welding. A straight butt weld is far better in fatigue than a

Figure 9 — In general, riveting construction is preferred in many ore bridge connnections by the designer because of fatigue considerations.



fillet weld but unfortunately is usually more costly due to the edge preparation required. Incidentally, fatigue failures are generally not in the weld but through the base metal adjacent to the weld.

When we come to the pier and shear legs, the dead load is a high percentage of the total, so that the live load fluctuations are a relatively small percentage of the total. This gives allowable stresses that are not so severe and welding becomes economical. Welded legs for ore bridges are now fairly common.

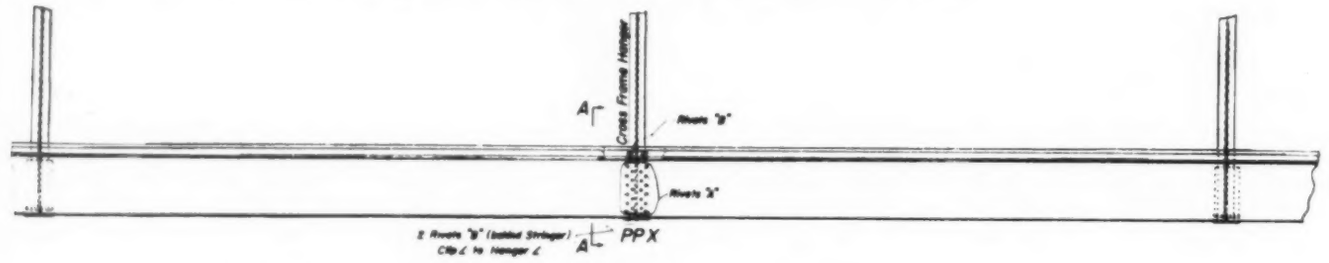
In speaking of riveted work, the question of high tensile bolts will come up. This rapidly growing method for fastening structural members has certain structural advantages, and for field connections appears to be more economical than riveting. It is particularly well adapted for repair work and helps solve two riveting problems—the increasing shortage of good riveting crews and the noise nuisance. It is important when high tensile bolts are used to have adequate control over the tightening process and to have competent inspection to insure that the bolts are properly installed.

4. *Features of design and details*—Because of the severe service of these bridges, they should be made quite stiff and rugged. Depth to span ratios of trusses generally run from $\frac{1}{7}$ to $\frac{1}{10}$ and for stringers from $\frac{1}{10}$ to $\frac{1}{14}$. L/R ratios for main compression members should be limited to 100, with secondary members allowed to go to 120. Even purely tension members should be kept fairly stiff to avoid vibration. Stringers should be made continuous by using moment splices, inasmuch as they will tend to act as continuous beams, whether figured that way or not.

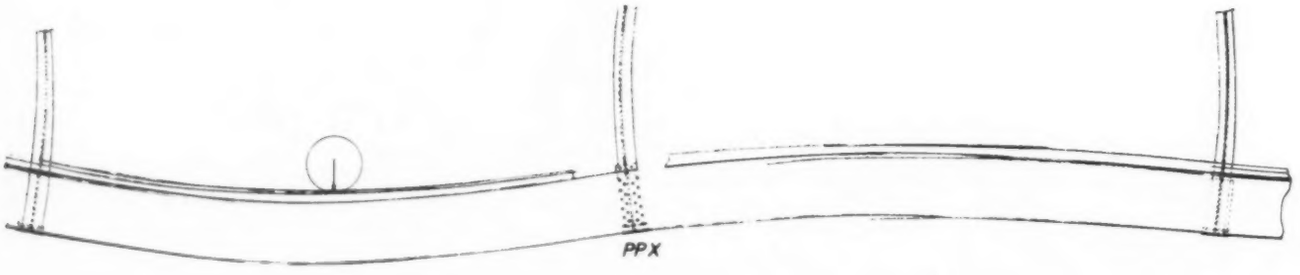
For the main span, both single and double web trusses have been used. Single web construction is where members are forked over a single gusset plate; in double web construction the members enter between two gussets. It is our opinion that an ore bridge is a structure of such magnitude and importance that double web construction should preferably be used for the greater rigidity and safety it provides (Figure 9).

Cross frames also have been built of single or double web construction, but here the situation is different. The use of a single web cross frame can reduce the secondary stresses induced by deflection of the stringer, and at the same time reduce the racking forces on the stringer connection. These stringer connections are critical fatigue-wise and should receive special care. Also, there is a tendency for the stringer web to develop a longitudinal crack just under the top flange at the panel points due to rolling of the top flange. Therefore, the top flange should receive some support from the detail at this point. The lower cross frame members can be subject to fairly high secondary stresses—longitudinally from the effect of stringer deflection and laterally from deflection of the cross frame itself (Figure 10). These should be considered in the design.

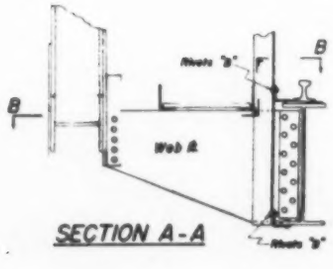
Figure 10 — Deflection in some bridge members can result in appreciable secondary stress.

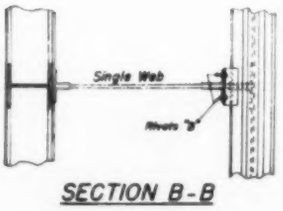


STRINGER AND CROSS FRAME HANGERS IN UNLOADED CONDITION



STRINGER AND CROSS FRAME HANGERS WITH TROLLEY WHEEL IN ONE PANEL
(DEFLECTIONS GREATLY EXAGGERATED)





Secondary bending moment at panel point X and in the hanger is low because the hanger is a slender flexible member. This bending is resisted mainly by rivets "B" (see Sections A-A and B-B), leaving rivets "A" to carry the design vertical load only.

Rivets "B" as shown are capable of carrying twice the computed secondary bending moment at the panel point.

In steel structures of any kind, and especially those subject to severe service, the careful design of details is of prime importance. All of the standard specifications give rules governing the details, but in the final analysis the quality of the details (and therefore of the structure itself) depends on the experience and thoroughness of the designers and detailers.

One question which usually comes up is how much of a connection should be provided for a member which is governed by say L/R and carries a low actual stress. The AREA specifications and AISE standard No. 6 require the member to be connected for its capacity regardless of actual stress. The AISC structural specification allows the computed stress in the member but not less than 10,000 lb or two rivets per member. It would seem uneconomical to provide heavy connections for members carrying light loads, but at the same time the connection should have some relation to the size of the member. A sliding scale is sometimes used, varying from 50 per cent of the capacity to the full capacity depending on the actual stress in the member.

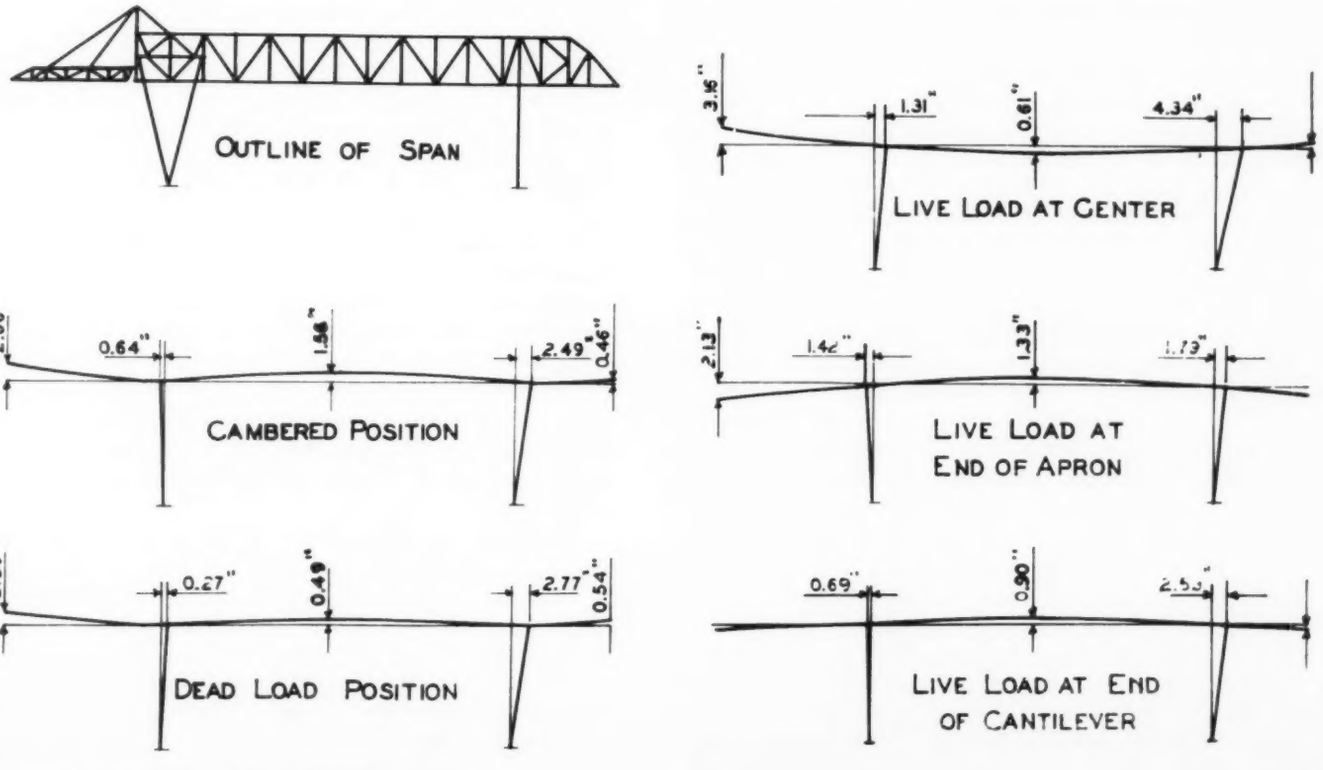
Minimum thickness of material is a feature on which the customer often has his own rules and sometimes strong feelings. The AREA specification requires $\frac{3}{8}$ in. minimum thickness of steel without exception. While in general, the $\frac{3}{8}$ in. requirement is suitable for high grade jobs, some exceptions seem to be in order. Webs of rolled shapes are often thin in comparison to their flanges and some weight can be saved without any real loss in quality by permitting such webs to be $\frac{1}{16}$ in. less than the general requirement. Minor parts such as stairs, handrailing, framing for enclosures, etc., are usually excepted from the general rule. The AISE Standard No. 6 limits thickness to $\frac{5}{16}$ in. which is satisfactory if maintenance is good. The AISC structural steel specification permits steel down to $\frac{1}{4}$ in. thick. This is too lenient for first-class ore bridge work.

Along with minimum thickness several other requirements for resistance to corrosion and ease of maintenance have become standard for ore bridges. Water pockets should be avoided in any structure but are particularly objectionable in ore bridges where ore dust will collect and remain moist for long periods. Laced members are now considered "taboo" and angles back to back with a narrow gap are avoided where possible. Where necessary, continuous fillers are used.

Camber for the span (Figure 11) generally follows usual practice and is provided for dead load plus half live load. Lean of the shear leg is a special problem peculiar to ore bridges. As the span skews, the shear leg leans inward to compensate for the slope distance between tracks. This can amount to 18 in. or more. Since skew is generally kept within a small angle, only occasionally going to the extreme (usually 5 or 6 degrees), the span is detailed so that the leg leans outward two or three inches when the span is normal. For the usually small skew angles, then the leg stays nearly vertical, and the extreme lean inward is reduced by this two or three inches.

The safety departments of most steel companies require that walks and stairs with handrailing on both sides be provided for access to all parts requiring regular service or attention. Ladders are used only for minor points or where stairs are not practical. Walks and stairs are usually two feet wide, although 2 ft-6 in. is sometimes called for. Forty-five degrees is generally accepted for slope of stairs, but flatter slopes would not add much to the cost of the structure. Open grating is popular for walks and stair treads, but checkered plate is still preferred by some customers. A common type of handrail now in use is solid round bars $\frac{7}{8}$ or 1 in. in

Figure 11 — Sketches show position of members under various load conditions for normal span with average temperatures.



diam. Since these can be cut and bent in the field, a considerable saving in drawing room cost is obtained.

Splices for trolley runway rails are a matter of opinion among the steel companies, some preferring a welded splice (usually thermit) to make a smooth continuous rail, while others consider that a fitted and bolted joint with splice bars will be less troublesome.

A special item, which should be mentioned here, is the use of synthetic rubber under the rails. This absorbs some of the impact and reduces maintenance on the track, but adds to the cost of the structure. This again is generally a matter of customer preference. Where synthetic rubber fabric is not used, a steel wearing plate should be placed under the rail.

5. *Materials of construction*—The basic material for an ore bridge is, of course, ordinary low carbon structural steel—ASTM A7. Low alloy steels covered by ASTM Specification A242 are sometimes used in aprons to reduce the dead load of this part, but seldom elsewhere. Low alloy steels have two drawbacks: (1) it is questionable whether the fatigue strength is much improved over that of low carbon steel; and (2) the higher unit stresses used result in greater deflections, an annoying feature of ore bridges. This latter drawback applies with even more force to the use of aluminum in ore bridges.

For welded portions, the new ASTM A373 steel should be used to reduce the possibility of brittle fracture. More will be said about brittle fracture later, but this steel was introduced to take the place of A7 steel in dynamic welded structures. It controls the brittle fracture characteristic by limiting the carbon content and requiring some silicon or aluminum for thicker sections. While A7 steel has been successfully used for many years on welded structures, authorities generally agree that for dynamic welded structures such as highway and railroad bridges, and therefore also ore bridges, the extra precaution of using A373 steel should be taken.

6. *Fatigue*—Fatigue has already been mentioned several times. It is a very important phenomenon and also a very complicated one. The study of fatigue in structural members is of comparatively recent origin. Most of our quantitative knowledge rests on laboratory tests of isolated members or joints, although some studies have been made on actual structures. Reports of these can readily be found in the engineering literature, particularly in the reports of the Committee for Fatigue Testing of the Welding Research Council, Bulletins of the University of Illinois, Bulletins of the American Railway Engineering Association, Proceedings and Separates of the American Society of Civil Engineers, Reports of the Committee for Riveted and Welded Joints, and similar sources. Of particular interest to engineers involved in the design or maintenance of ore bridges is the report on "An Investigation of Fatigue Failures in Structural Members of Ore Bridges under Service Loadings" by Professors L. T. Wyly and M. B. Scott of Purdue University and carried out in co-operation with the United States Steel Corp. This is published in Bulletin 524 (September-October 1955) of the American Railway Engineering Association. This is a 123-page report on a series of field tests made on ore handling bridges and includes a study of actual failure records of members of this type of bridge.

Very briefly stated, measures that should be taken to avoid fatigue are: (1) the use of reduced unit stresses; (2) control of details to avoid stress raisers, among which are sudden changes in section, re-entrant cuts, etc., (3) control of workmanship to avoid sharp cuts or nicks, ragged rivet holes, rivet holes stretched by overpinning, etc., and (4) the avoidance of welding beads on critical areas, such as across a tension flange.

7. *Special considerations*—(a)*Brittle Fracture:* Brittle fracture came into prominence during World War II when a number of welded Liberty ships broke in two. This phenomenon later was pretty much eliminated in ships by better design of details, particularly around the hatch openings, and was further guarded against by slightly closer control of the chemistry of the steel used. The ASTM A373 steel mentioned earlier is an application of this latter principle to steel for structures.

Although there is no connection between fatigue and brittle fracture, the precautions taken to prevent fatigue failures will also serve to prevent brittle fracture. The danger of brittle fracture occurring in ore bridges is not too great; however, it is recommended that A373 steel be used for main welded parts.

Due to the depletion of the Mesabi ore ranges, new fields are being opened up, some of them in northern areas subject to extreme cold. If ore bridges or similar structures are to be built in such climates, then the problem of brittle fracture should be given more consideration. For those interested in pursuing this subject further, we recommend a book entitled "Control of Steel Construction to Avoid Brittle Fracture," published by the Plasticity Committee of the Welding Research Foundation.

(b) *Laminations:* For welded work it is necessary to consider the possibility of laminations in the steel. A lamination, as the name implies, is a flat area within the steel where the bond between the adjacent surfaces is missing. Its occurrence is frequent enough to require precautions against it wherever its presence may be dangerous. Generally speaking, details of welded work should be arranged so that tension is not carried through flat areas of steel. Where this cannot be avoided, then the area in question should be tested by taking plugs, by supersonic testing, or other means. Fortunately, laminations appear to be less prevalent now than they were a few years ago.

8. *Workmanship*—It follows that workmanship on such structures should be of high quality. The AREA specifications are a good guide in this respect, although current general practice often omits the reaming of holes for shop rivets in main connections, as is called for in these specifications. The report by Professors Wyly and Scott mentioned previously would not condone this practice, and in fact recommends a much higher quality of workmanship than we now have in any structures.

This paper has attempted to bring out and explain the main problems and recommended practices for the design of structural parts of ore bridges and similar structures. In the space available it was possible only to touch on the many features involved, but it should have brought out the severity of service endured by these structures and the need for careful and adequate design. ▲

Progress In Developing Fire-Resistant Hydraulic Fluids

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Continuous progress is underway by a number of groups, working together, to produce a non-flammable hydraulic oil which will have the required lubricating properties, which will have no harmful side effects, and which will be economically competitive.

BEFORE describing the Bureau of Mines fire-prevention research program, it is desirable to quote Dr. Kettering's definition of research: "Research is an organized method of finding out what you are going to do when you can't keep on doing what you are doing now."

Fire is both an enemy and friend of man. Out of control, it is a great equalizer that indiscriminately sows misery and destruction among rich and poor alike.

It is customary at this point to quote fire-loss statistics at great length, but they are available from many sources. It is enough to know that every fire is potentially dangerous and under certain combinations of circumstances can cause loss of life and property. While the fire-prevention efforts of the Bureau are directed mainly to coal mining, the problems and hazards related to fire are common to all industries.

For many years the hazard from mine fires has been accepted, as many other hazards continue to be accepted, as an inevitable part of a dangerous industry. For years the subject has been discussed, but little progress has been made in combatting and minimizing it.

However, recent years have brought a change in human behavior and thinking. For want of a better term this will be called a humanitarian evolution. Man's concern for his own safety and that of his fellows is on the march. His desire to utilize every resource at his disposal to safeguard himself, his property and his fellow man is reflected in the coal industry by the programs of the Federal Bureau of Mines, State Departments of Mines, mine operators, mine workers safety organizations, and mining institutes throughout coal-producing areas, and this awakening interest in safety is true of industry in general.

The responsibility for surrounding their products with safeguards to a degree hitherto unheard of has been willingly accepted by those who provide industry with the equipment and supplies that make modern mechanical production possible. This unprecedented co-operation has been manifested in the research project covered by this paper.

The gradual increase in size and capacity of hydraulically operated mine equipment has greatly increased the fire hazard. A tremendous amount of flammable hydraulic oil is taken into the face regions of mines. Mining equipment constructed to comply with the Bureau's rigid rules of permissibility is often filled with more than 50 gal of flammable fluid and is operated in face areas where fire is always a possibility. Early in 1956, therefore, the Bureau of Mines began a program to encourage and inspire development of a reasonably priced fire-resistant hydraulic fluid meeting operating requirements.

OPERATING CONDITIONS

Mining machinery is designed to operate in a limited area that may be rather high (over 7 ft), medium high, or extremely low. In any case, the machine is designed to fit into the area, and overhead room is usually limited. The width of the area of operation varies with the system of mining, the condition of overhead strata, and the type of support used. Overhead clearance frequently is measured in inches rather than feet.

The work of mining coal is in itself arduous, the coal varies in hardness and is often studded with impurities, and the bottom over which the machine has to travel can be rough and changeable in grade. Difficulty in travel causes many severe bumps and stresses. Often a machine is one of many operational units, and there may be frequent contacts between such machines.

These loosen bolts and joints in equipment and cause distortions, or they may result in tightening that causes increased friction and in turn brings about greater internal heating. The difficulties of maintenance should be considered, as it is not feasible to remove the machine from its working position (often five or more miles from the surface or underground repair shop) for repair or adjustment. Repairs generally are made in the restricted area where the machine operates, usually under adverse conditions. In addition, the operator of the machine and the mechanic who is repairing or adjusting it work in poor light—generally that of the cap lamps they wear.

Leakage reduces the quantity of fluid in the hydraulic system of the machine, causing extra heating as the level in the tank drops and the heat-exchange factor is reduced. It also contributes to the unsightly condition in which mining machines are often found—generally with an "overcoat" of loose coal, coal dust, grease and oil. Because in many instances coal mining is a marginal operation, frequently the machines do not get adequate care, maintenance and overhauling. Repairs are generally made under stress, when a machine is broken down and production stopped; however, a trend toward preventive maintenance seems to be alleviating this condition. Often a machine is operated by one with too little experience, especially where there is a labor shortage or absenteeism, and where a "staggered lunch hour" is in effect. In the design of a mining machine, space is always at a premium, and placing the hydraulic components is a problem. Therefore, tanks generally are smaller than those used in other industrial equipment.

So far it appears that a rather gloomy picture has been painted, but in spite of all the dark shadows, approximately 300,000,000 tons of coal are mined annually by hydraulically actuated equipment.

HYDRAULIC APPLICATIONS

The hydraulic applications and the type of machines used are too numerous to list here. However, data showing the types of equipment and the extent of use are given in Tables I and II. The pressures employed and type of equipment vary, and each manufacturer has his own opinion, which is expressed in the design and construction of mining machinery. Every type of hydraulic pump and motor in general use at one time or another finds its way into the assembly of the mining machine. However, gear pumps and piston pumps seem to be used more often than other types. The flexible hoses used

TABLE I

Recapitulation—hydraulic fluid survey (actual from reports)

Bureau of Mines office	Number of mines surveyed	Number of employees	Hydraulic fluid used (gal)*	Coal produced (tons)	Coal produced per gal (tons)
Pittsburgh, Pa.	71	21,317	1,544,480	24,233,091	15.69
St. Clairsville, Ohio	32	5,106	23,589	866,725	36.74
Birmingham, Ala.	19	5,825	110,217	4,296,400	38.98
Johnstown, Pa.	31	7,487	101,447	3,128,769	30.84
Norton, Va.	91	11,543	77,510	2,496,451	32.21
Barbourville, Ky.	39	5,150	74,039	3,103,219	41.91
Seattle, Wash.	5	341	1,140	47,452	41.62
Vincennes, Ind.	49	12,020	150,159	7,596,197	50.59
Morgantown, W. Va.	68	9,781	161,345	4,098,997	25.41
Mt. Hope, W. Va.	201	36,594	947,814	29,964,879	31.61
Denver, Colo.	63	4,642	300,662	7,716,212	25.66
Jellico, Tenn.	9	951	3,155	547,125	173.42
Grand total	678	120,757	3,495,557	88,095,517	25.20

* The above quantities were obtained on a weekly, monthly or yearly basis, whichever was easiest for the mine operator to furnish. The quantity of fluid is that required in producing the corresponding tonnages.

TABLE II

Hydraulic fluid survey (equipment using hydraulic fluid)

Bureau of Mines office	Number of mines surveyed	Number of employees	Cutting machines	Loading machines	Drills, roof-bolters, timbering machines	Shuttle cars	Continuous miners	Hoists, car-spotters, compressors, etc.	Total units
Pittsburgh, Pa.	71	21,317	546	685	248	530	124	93	2,226
St. Clairsville, Ohio	32	5,106	72	151	87	129	15	6	460
Birmingham, Ala.	19	5,825	83	129	71	187	7	83	560
Johnstown, Pa.	31	7,487	115	182	59	253	61	32	702
Norton, Va.	91	11,543	134	328	111	389		7	969
Barbourville, Ky.	39	5,150	55	153	23	163		14	408
Seattle, Wash.	5	341		2			6		8
Vincennes, Ind.	49	12,020	230	300	201	521	12	37	1,301
Morgantown, W. Va.	68	9,781	207	326	260	325	25	21	1,164
Mt. Hope, W. Va.	201	36,594	481	978	246	1,036	58	151	2,950
Denver, Colo.	63	4,642	127	200	108	209	9	23	676
Jellico, Tenn.	9	951	12	21	1	11			45
Total	678	120,757	2,062	3,455	1,415	3,753	317	467	11,469
Hydraulic system capacity, range in gallons			20 to 90	7 to 50	15 to 100	5 to 30	33 to 180	10 to 40	

vary in design, size and composition, but all are subjected to flexing and wear far in excess of that encountered in industrial equipment. For the pressure range we quote three of the large manufacturers of mining equipment:

> "We work in the 0- to 1500-psi range and find it adequate for most applications. Mining machines are not going to fly. The cylinders need to be rugged and heavy to withstand mine service. The 0- to 1500-psi range seems to be right for cylinder applications, and we try to keep the working pressures low. High pressure circuits do offer increased efficiency and a wider range of working pressures for motor applications, and we now have several machines using the 0- to 2000-psi circuits."

Another manufacturer states:

> "Approximately 85 per cent of our hydraulic pumps and motors are of the piston type and operate at pressures with the release valve set at 2100 psi. The remainder is divided between vane pumps having a release valve set at 1800- to 2100-psi and gear pumps set at between 600- and 2100-psi."

The third large manufacturer uses piston pumps and vane pumps with pressures up to 2000 psi. The hydraulic fluid recommended by these manufacturers is generally within the range of 150 to 300 SSU (standard Saybolt universal) at 100 F. More will be said on that later.

Before proceeding further, attention is called to a Bureau of Mines survey to determine the quantity and type of hydraulic fluid used in operating coal-mining equipment. Reports submitted by 12 District and Subdistrict offices of the Bureau cover 14 bituminous-coal-producing States. A total of 678 coal mines was surveyed; 619 of these employed 15 or more men, and this constitutes 46.3 per cent of the mines employing 15 or more men in the States surveyed and approximately 43 per cent of the 1432 Title II bituminous-coal mines in the United States. See I.C. 7734, Administration of Federal Coal Mine Safety Act 1954, p. 44.

The 678 mines surveyed (Table I) employed 120,757 men and produced 88,095,517 tons of coal during a period in which 3,495,557 gal of hydraulic fluid was used in 11,469 units of mining equipment. Many of the units had a capacity of more than 50 gal of hydraulic fluid, as shown in Table II. The survey indicates that one gallon of hydraulic fluid is used for each 25.2 tons of coal mined mechanically. A projection of the data for estimating yearly consumption, based on a 50-week operating period, indicates that the mines surveyed would use 10,325,337 gal of hydraulic fluid and produce 291,876,420 tons of coal, or 28.27 tons per gal. This quantity of fluid would cover more than 1000 miles of 12-ft entry to a depth of ¼ in.

It is therefore reasonably safe to assume that, in mining 300,000,000 tons of coal by mechanical means, more than 10,000,000 gal of hydraulic fluid would be consumed. Since the industry hopes to double coal production within 10 years, the amount of hydraulic fluid required would be increased accordingly, barring radical changes in design and maintenance of equipment. All fluids used in the mines surveyed were petroleum products and therefore flammable.

A scrutiny of the survey data and other information obtained from mine operators, equipment manufacturers and producers of hydraulic fluid indicated that such fluids are purchased on the basis of price rather than scientific determination of quality for safe and efficient use. Our reports show that while equipment is under factory guarantee, the proper fluid as recommended by the manufacturer is used. At the expiration of the guarantee period, price generally becomes the chief consideration. This is not a theoretical statement: it was arrived at after careful study of the specifications and price range of the hydraulic fluids recommended by the manufacturers of mining equipment and the information received at the mines during the survey. Since hydraulic systems are closed and the amount of additional fluid required after the system has been filled should be relatively small in the opinion of the manufacturers, we can conclude from the survey and from statements by operators and oil distributors that leakage is a major factor in the consumption of hydraulic fluids.

IGNITION HAZARDS

Between July, 1952 and January, 1957 the Bureau investigated 160 coal-mine fires, 91 of them of electric origin.

Hydraulic fluids contributed to the creation of certain of these fires or became involved after the ignition in some of the fires. The possibility of the hydraulic fluid becoming involved in any fire should not be overlooked. Every effort should be made to develop a fluid which will be fire resistant and obtainable in quantity at a price comparable to that of the flammable fluids now used.

Excerpts from recent Federal reports of coal-mine fire investigations follow:

Date	*Place*	
April, 1957	Ohio	A loading machine was being maneuvered when the front wheel passed over the trailing cable as the machine moved forward, rupturing the insulation and causing an intense arc as the positive conductor came in contact with the wheel and the rail. The 300-amp fuse at the nip of the trailing cable did not blow; and the motorman, who saw the arc, removed the nip immediately. However, before the nip could be removed, the hydraulic hoses immediately above the location where the arc occurred became ignited and burned. The fire from the burning hoses and escaping hydraulic oil also spread to the wiring in that section of the machine.
March, 1957	Pa.	This fire occurred as the consequence of a short circuit in the stator winding of a 2-hp, 3-phase, 440-volt, a-c induction motor on the lower level of the rotary-pump installation, the flame of

		which then ignited and burned the hose and other parts of the hydraulic system containing 20 gal of flammable hydraulic fluid and extended to the 3-in. thick wood floor, four feet above the the motor. The heat from this fire was sufficient to melt and burn a large part of the electrical wiring system in pipe conduit in the immediate vicinity of the fire area. Investigation disclosed that the 2-hp motor, pump, hydraulic hoselines, and telephone and electric wires in pipe conduit had been damaged beyond repair.
February, 1957	Pa.	Colmol and shuttle car. Trailing cable crushed between bumpers of Colmol and shuttle car, causing short circuit. The position of the shuttle under the rear conveyor of the Colmol further hampered efforts to smother the fire, which increased in intensity owing to emission of hydraulic oil.
January, 1957	Ky.	The fire was caused when the power wires in the distribution box on a mining machine blew up, igniting the hose and oil. The machine was engulfed in flames and smoke, and fumes hindered fire fighting. Sixty-seven men were underground at the time.
January, 1957	Ohio	Continuous miner; 56-gal hydraulic oil capacity. Bumped by shuttle car; trailing cable damaged. The arc from the short circuit ignited the insulation and loose coal lying on the machine; and the fire spread to the hydraulic hoses nearby, causing the hoses to rupture and the escaping oil to burn.
December, 1956	Ill.	Mining machine. An arc between power wires ignited hydraulic hose and accumulations of oil and coal dust on machines. Tires burned.
November, 1956	W. Va.	Mining machine. The fire started when a short circuit occurred in a cable, or cables, leading from the control panel to the cutting motor. The resultant fire ignited accumulations of oil-soaked coal dust and fine coal beneath the top cover plate of the machine. About 50 gal of hydraulic oil in tank were vaporized and consumed by the fire.
November, 1956	Pa.	Mining machine; 30 gal hydraulic oil. The fire resulted from an arc produced by the mining machine running over the trailing cable, which in turn ignited hydraulic-oil spilled on machine. Hydraulic hoses scorched; fire put out before they burned.
October, 1956	Pa.	Shuttle car; hydraulic-fluid capacity, five gallon. Short circuit in cable, hoses and oil ignited.
August, 1956	Pa.	Cutting machine. A flash of fire at the cable-reel junction block ignited oil accumulations on the decking.
June, 1956	Ohio	Shuttle car. Steel crossbar fell on shuttle car. Other end contacted bare feeder cable, resulting in short circuit that caused fire. Hoses and only small quantity of oil involved in fire, as it was put out quickly.
May, 1956	W. Va.	Shuttle car, rubber tires. Short circuit in splice on part of cable wound on reel; ten gal of flammable hydraulic fluid in system not ignited.
April, 1956	W. Va.	Cutting machine working harder than usual. Resistance became too hot and ignited power cables and, in turn, trailing cable. The 56 gal of flammable hydraulic fluid in the hydraulic system remained intact.

You will notice that in the last two instances the hydraulic fluid was not involved in the fire, but there is no guarantee that this could happen again under identical circumstances.

STUDY OF HYDRAULIC FLUIDS AVAILABLE AND USED

A Bureau study of the flammable characteristics of the petroleum-type hydraulic fluids used and available discloses a range of more than 200 F between high and low flash and fire points, and shows that when such fluids are ignited, all propagate smoke and flame. Although there are no universally accepted standards for fire-resistant hydraulic fluids, tests established by individual groups are used to judge fluids offered to industry as fire-resistant. The American Society for Testing Materials is making an effort to standardize such tests and make them more applicable to the conditions under which the fluids are used.

A description of fire-resistant fluids now available follows:

Straight synthetic fluids—This class of hydraulic fluids comprises the phosphate-ester and chlorinated-hydrocarbon compounds, which are designed as nearly as possible to duplicate the properties of petroleum oils. Users report that these products, although somewhat inferior to high-quality petroleum oil, will provide fully satisfactory performance in the hydraulic elements of mining equipment operated underground. However, experienced advice should be sought in selecting hoses, rings, and seals, as some materials used in manufactur-

ing these items are affected adversely by the fluids. These fluids cost approximately $3.50 a gallon.

Water-base synthetic fluids—This class of fire-resistant hydraulic fluids comprises essentially mixtures of water, polyglycols and additives. The mixture is factory made. Users report that the products, containing 30 to 40 per cent water, are stable at 140 to 150 F maximum but must be checked occasionally to maintain the water and additive content at prescribed levels. A study indicates that these products can be expected to perform satisfactorily in mining equipment under most conditions. They are compatible with the seals, packings, and hoses normally used. However, in common with the straight synthetic fluids, they tend to "lift" the paint in reservoirs. These water-base fluids cost approximately $2.50 a gallon. Should the use of fire-resistant hydraulic fluids increase substantially, it will be reasonable to expect a decrease in price.

Water-soluble oil emulsions—There are two basic types, oil-in-water and water-in-oil. Their use as hydraulic fluids has been explored to a limited extent during recent years, but no thought or tests were devoted to such fluids for use in mining machinery before this project was undertaken.

Water-soluble oil is generally a petroleum product to which an emulsifying agent has been added and is used in conjuction with water. The amount of oil is normally far less than the amount of water, making fire resistance possible. Besides being a quenching agent, water when turned into steam, also is a "snuffer" in case of fire.

Water-in-oil emulsions are relatively new. In making them a globule of water is forced into a globule of oil; the oil, being on the outside, furnishes some of the lubricity required to keep the hydraulic pumps operating properly and economically; the pumps, in most instances, depend on the hydraulic fluid being pumped for self-lubrication. Several producers are now working on this fluid; one product is already on the market at approximately $1.25 per gallon. This fluid has been used in industrial machinery with good results; but, so far as known, no tests have been made under actual operating conditions in coal mining.

Oil-in-water emulsions are made by surrounding globules of oil with globules of water; therefore, the water is on the outside, offering less lubricity than other commonly used or recommended fluids. Such fluids are generally milky in color, and when mixed with water, in ratios wherein the oil is only 2 to 3 per cent of the total, they are commonly used as coolants and cutting fluids in metalwork. Fluids of this type are being used in hydraulic systems employing triplex plunger pumps. However, it is generally concluded that they would not have the film strength required to protect the kind of pumps commonly used in coal-mine equipment hydraulic components designed for oil.

This matter has been discussed with numerous hydraulic and lubrication engineers employed by producers of hydraulic fluids, manufacturers of mine equipment and hydraulic components, and users, and it was concluded that the oil content of such emulsions could be increased to a range of 25 to 40 per cent, thereby getting utility as well as fire resistance. The cost of such fluids should be favorable compared with that of flammable fluids now in use.

The possibility of dehydrating the water-base fluids and emulsions before shipment and storage, and adding the water when ready for use by consumers, has been discussed by the Bureau with representatives of producing companies. This should lower the price.

Bureau investigators conferred with the manufacturers of mining equipment and hydraulic components of such equipment to discuss the proper types of hydraulic fluids for use in their products, the applications and limitations of such fluids, and arrangements for tests when fluids are available. The information procured was then discussed with research staffs of oil and chemical companies. This was not confined to large companies, as these conferences were held with any producer of hydraulic fluid who expressed interest in discussing fire-resistant hydraulic fluids for use in mining machinery. A large meat-packing organization is also interested in developing an emulsion using animal fat as a base. Representatives of the United Mine Workers of America, the National Coal Association, the Bituminous Coal Operators Association, the Southern Coal Producers' Association, and Federal Bureau of Mines personnel met to discuss the part each must take in this project to assure success.

At a meeting of the N (Technical Committee on Fire-Resistant Hydraulic Fluids) Subcommittee of the D-2 Petroleum Committee of the American Society for Testing Materials (ASTM) in New Orleans during February of 1957, it was agreed that, since mining equipment differs greatly from industrial equipment in design, use and work characteristics, a special group within the industrial applications section would study the situation and recommend tests that will be suitable for the fire-resistant fluids that are being and will be developed for coal-mine use. This committee consists of the hydraulic engineers of three large mine-equipment manufacturers and two pump manufacturers, and is headed by the writer, representing the Federal Bureau of Mines.

RESEARCH, DEVELOPMENT AND TESTS NOW IN PROGRESS

Bureau of Mines research is in progress to develop test methods for evaluating the fire-resistance of hydraulic fluids. A Federal schedule for accepting such fluids for listing as fire resistant will then be published.

Intensive research programs also are being conducted by many manufacturers of hydraulic fluids. In addition to the previously mentioned products, ready or under development, experiments are being conducted with solutions, suspensions and other compounds as yet nameless. For instance, one manufacturer is developing a product that, for want of a better name, we will call a viscous-lubricious liquid. However, assurance that the project will succeed has been given to the writer by several such manufacturers. An excerpt from a letter dated April 1, 1957, follows:

> "On the basis of your fine presentation of the problems facing the mines relative to the use of fire-resistant hydraulic fluids, we are in the process of evaluating materials that will meet your requirements. This work should not take too long—possibly another month—before we will be in a position to discuss the fluid and the setting up of a test. We will contact you as soon as possible."

Since that time a fluid has been developed and is being tested at the moment.

Tests also are being conducted in the laboratories of producers of hydraulic fluids and manufacturers of mining equipment and components. Several large users of hydraulic fluids have begun or are inaugurating test programs. The National Tube Division of the United States Steel Corp., a large user of hydraulic fluid in mine and mill, has done an extensive amount of testing, and it has enough experience to make a good comparison between currently used petroleum products and the fire-resistant hydraulic fluids now available and under development. An experimental fire-resistant fluid, when tested, compared favorably to the premium-grade petroleum fluids now in use; other such fluids are scheduled for testing. The Lubrication Department of the National Tube Co. is co-operating fully with the Bureau in the effort to find a suitable fire-resistant fluid for mine use.

The pump rig at its laboratory is an entirely closed system, with a $3\frac{1}{2}$-gallon capacity, welded-steel reservoir, and a water jacket operated automatically by an arrangement that effectively controls the selected test temperature. There is no work load, and a constant pressure of 1000 psi is maintained. The complete gallonage is dumped over the relief valve, and a meter is used for measuring the total gallonage. A 2-hp motor runs the pump shaft at 1120 rpm. A 50-mesh stainless-steel strainer, full flow just before inlet into pump, filters the fluid. The pump has a rated capacity of 1.9 gpm at 1000 psi at temperature of 120 F. Operating temperatures in the main have been 175 F for all petroleum-oil fluids and nonaqueous synthetics and 150 F for aqueous solutions and emulsions. The choice of these two temperatures, which admittedly are high for most operations, was made to accelerate the test. The test runs for 1000 hr unless loss of pressure signifies an earlier end. Constant pressure of 1000 psi is maintained throughout the test. A great advantage of the simulated service test is in checking the deterioration of the fluid itself along with indications of wear on the pump. Tests for increase in viscosity at the operating temperature, neutralization number, precipitation number, and color are made at the 250-, 500-, 700-, 775-, 850-, 925-, and 1000-hr stages of the test. The wear indication on the pump parts is made only at the conclusion of the test.

ACTIVITIES PROGRAMMED AND ANTICIPATED

Field tests will be conducted in mines under actual conditions and evaluated by producers as well as users of fluid and equipment. It is anticipated that each will carefully study such fluids as they are tested and also consider a very important factor—that although producers of mining equipment specify high-grade, inhibited hydraulic oils, it has been found that many users disregard the specifications and use a very cheap grade of hydraulic fluid. We assume that leakage is a large factor. However, one must consider that the low-grade fluids must perform at least to a *tolerated degree of acceptance* by the users to continue in use, and that any fluids developed at a price comparable to that of the cheaper fluids now in use should not be expected to give performance equal to that of the designated inhibited fluids not generally used. It is hoped that the fluids being developed will be at least as good as, if not better than the cheaper fluids now used. Should a better grade of fluid be desired at a higher price, it will be available. ▲

Weirton Donates Mill for Research

AFTER a 40-year career in the steelmaking business, the No. 12 cold mill from the 10-In.-16-In. Strip Steel Department at Weirton Steel Co., division of National Steel Corp., has been donated to Syracuse University, Syracuse, N. Y., for use in research and experiments.

The mill was dismantled and shipped to Syracuse on June 25, complete with drives, reels, motors, and control. Also included was a 100-kw motor-generator set.

Syracuse University will use the mill primarily in efforts to improve the quality of steel mill rolls. The mill will be used to investigate not only the rolling processes, but also how roll materials react under different rolling conditions. The mill will be operated by employees of the Institute's metallurgical research laboratory and will also be used to study load distribution, fatigue, temperature variation and roll wear. This work is part of a joint roll research project financed equally by the Roll Manufacturers Institute and the Association of Iron and Steel Engineers. The research program is under the direction of a combined AISE-RMI roll research committee.

The mill, a two-high rolling unit requiring an operating crew of four men, was used at Weirton until it was replaced by the installation of newer, faster and more efficient equipment in March, 1956.

The 25-ton mill was one of eight of the same type that the Phillips Sheet and Tinplate Co., Weirton Steel's predecessor, bought in August, 1916. The job titles of the crewmen who operated the mills—feeder, roller, catcher and piler—have become classic in the industry.

Two-high mills of the No. 12 type were used throughout the steel industry for many years before World War II, but their use was declining by 1940. Heavy demand for steel and the lack of new equipment brought them back into full service again when maximum production was necessary during the war. During World War II, the mill rolled clip stock for ammunition and also brass, copper, aluminum, magnesium and silver chloride.

Throughout the war years and the reconstruction period that followed, No. 12 and other mills of the same type were in round-the-clock operation. They were used extensively for special process orders in the production of steel sheets.

New developments in the temper mill process were incorporated in the modern tandem cold mills installed in the 54-in. strip steel department. These new units made the old two-high mills obsolete, even for special process orders. One of the old mills is being held in storage, however, in case its operation should ever be required in the future.

by W. E. Schwabe, Product and Process Development Laboratory,
National Carbon Co., Div. of Union Carbide Corp., Niagara Falls, N. Y.

Lighting Flicker Caused by Electric Arc Furnaces

. . . . erratic changes in arc length cause two types of current swings during melldown. . . . degree of disturbance depends on relation of furnace load to stiffness of power system. . . . hollow or cored electrodes reduce load swings at a cost of increased rate of consumption. . . .

ARTIFICIAL light sources such as incandescent light bulbs require a high degree of uniformity in the operating voltage. The human eye is capable of detecting minute variations of light emission especially when they occur in a cyclic sequence.

Some types of electrical equipment such as pumps, welding machines, and electric arc furnaces can, under certain circumstances, initiate short timed voltage fluctuations and create a condition known as lighting flicker.

The problem of lighting flicker has been the subject of theoretical and experimental investigation during the past 20 years, and numerous papers have been published. In the course of this work, emphasis was put on corrective equipment for elimination or reduction of the disturbances. Furthermore, power companies established limits for the maximum tolerable voltage fluctuations in their networks based on cyclic recurrence of voltage dips at various frequencies.

During our research and development work on electric arc furnaces, we have investigated the behavior of the arc under various conditions of operation. It was found that the unsteadiness of arcs is the cause for the disturbances, and that it depends to an appreciable degree on the structure of that part of the electrode which is engaged in providing the arc.

The purpose of this paper is to present new results and views to the problem in the light of recent experimental work on the behavior of electric arc furnaces in network and their influence upon artificial light sources. It is not intended to discuss corrective electrical equipment but rather to explore the possibilities of influencing the behavior of the arc proper.

CONDITIONS OF ARC INSTABILITY AND CURRENT SWING OF ELECTRIC FURNACES

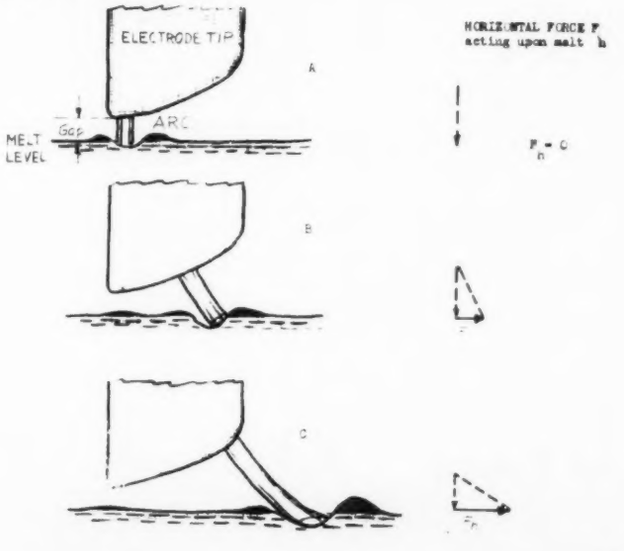
Operating conditions of the arcs and their specific unsteadiness reflected in the rate of current flow were presented in a paper at the 1956 AISE Annual Convention. See article "Experimental Results with Hollow Electrodes" by W. E. Schwabe, 1957 Proceedings AISE.

It was shown that erratic changes of the arc length caused by external and internal forces and random contacts between collapsing scrap are responsible for current swings.

In agreement with the results of other workers it was found that in essence two types of current surges create line voltage dips.

1. *Type A*—Flicker also called "Extreme Frequent Flicker" in the literature occurs mainly during the first 15 to 30 min of melt down. Extremes as to magnitudes can be observed immediately at beginning of the heat when the arc is started by short circuiting the electrode with the melt followed by frequent extinctions. (Current swings between zero and short circuit.) Extinctions of the arc become less frequent when the electrodes "drill" a path through the scrap, but scrap cave-ins, large or small, cause temporary full or partial

Figure 1 — Arc flares in electric steel furnaces are caused by horizontal forces.



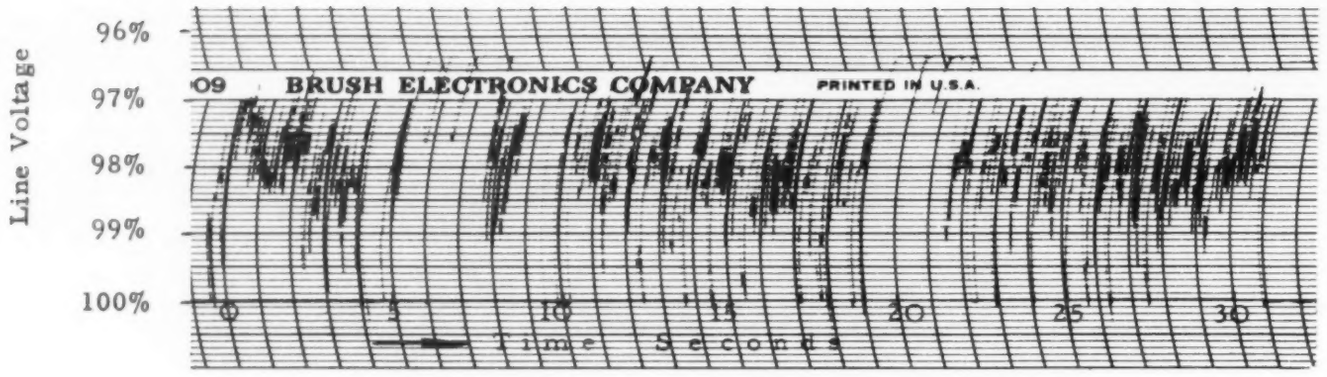


Figure 2 — Lighting flicker caused by a-c arc welding includes both types of flicker.

short circuits with the electrode. Even after a sizable pool of liquid metal has been established, surges up to short circuit values have to be expected. Since they occur at a rate of less than one per second, they are classified as Type A.

2. *Type B*—Flicker or "Cyclic Flicker" is caused by dislocation of the arc in conjunction with hydrodynamic conditions of the melt in the vicinity of the arcs, as described in the above mentioned paper. The mechanism of this condition is qualitatively described in Figure 1.

a. Figure 1A illustrates an initial arc under the electrode. The gap G is small and, therefore, the current is high, and the corresponding power factor is low. A vertical force acts in the direction of the arc causing a depression in the melt. Due to the magnetic influence of the two adjacent electrodes in connection with the magnetic field surrounding the current paths in the melt, a horizontal force F_h is exercised upon the arc tending to displace it toward the shell. Figure 1B shows the arc in a new position. The axis of the arc is no longer a straight line. Since it also displays an angle with reference to the vertical, the arc force now has a horizontal component F_h pushing the melt in the direction toward the furnace shell. Once a floating hot spot on the melt has been established, it is easy for the arc to jump into the extreme position (illustrated in Figure 1C) with a very pronounced downward bow and a considerably increased horizontal force component F_h. If the hot spot on the melt offers an arc supporting effect by improved thermoionization (such as floating slag or impurities do) the arc has the tendency to remain on this spot until the particles have been forced far enough so that the arc no longer can exist.

b. Shortly before the arc is subjected to extinction, a new arc has started at the heel of the electrode as in

Figure 3 — Chart shows fluctuation of arc current — phase B, and primary voltage phase B-C at furnace bus during meltdown of a 140-ton furnace. Current rating is 45,500 amp.

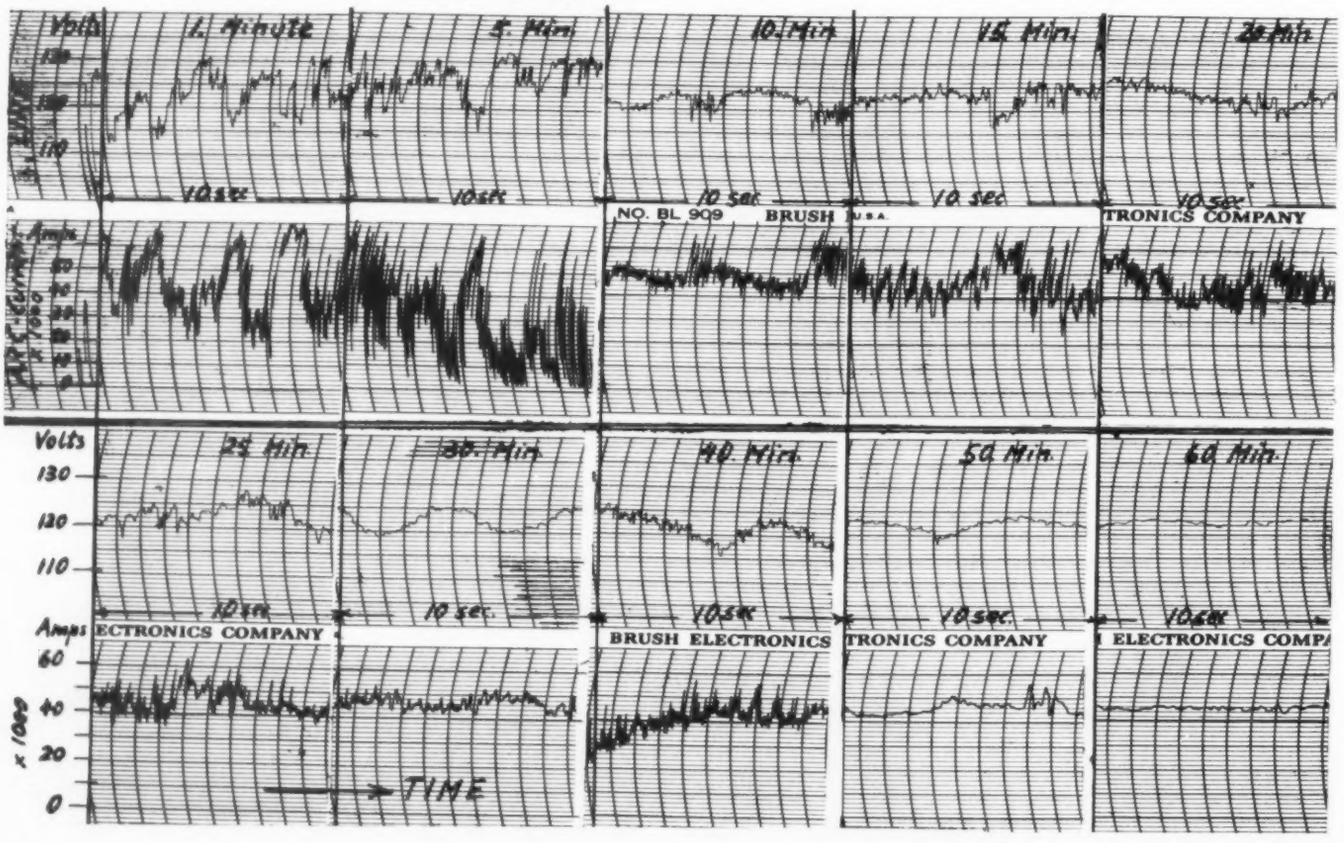


Figure 1A, either by electrical breakdown or by physical contact of a wave crest with the electrode, depending on the gap and the degree of turbulence of the melt. Thus we have a more or less cyclic variation of the effective arc length due to the magnetic field (arc flare).

c. In addition to this effect, it has been observed that the arc in the fixed position of Figure 1C changes its length due to waves on the surface of the melt.

d. Furthermore, temporary rectification or partial rectification of the current can take place thus reducing the effective value of the current considerably.

e. Another influence governing the current is given by sudden changes of the electrical conductivity in the arc zone due to explosion like vaporization of arc supporting material. At a given arc length the electrical conductivity may be improved up to 50 per cent and falling back to its original value almost instantaneously after the arc supporting material has been consumed.

Type B flicker is caused by one or more factors described above or by an erratic combination. It usually results in current fluctuations of a frequency between two and eight per second.

It will be discussed later that the reaction of load swings upon the network is a question of the ratio between the magnitude of the surges and the stiffness of the network. In this connection it is interesting that for example, electric arc welders in rural networks can create sizable disturbances, although their capacities are of a much smaller order of magnitude. Figure 2 illustrates the line voltage recorded with special instrumentation in the vicinity of an a-c arc welder. The shape of the line voltage trace reflects exactly the current fluctuation during the welding process. Note that both Type A and Type B disturbances are present.

ANALYSIS OF HIGH SPEED ARC CURRENT CHARTS

In order to get a picture of magnitude and rate of occurrence of load swings in furnace arcs we used a special recording technique and analyzed numerous heats at various furnaces. One typical example is shown in Figure 3.

The arc current of phase B and line voltage, at the furnace bus phase B-C were recorded with a high-speed recorder. Fluctuations of the current are reflected in the line voltage. It should be stressed that the recorded voltage at the furnace bus is not identical with the general network voltage. In this case the latter is stabilized by corrective equipment. As an example, this diagram shows ten selected intervals of 10-sec duration each taken during a meltdown of a 140-ton furnace. The chart speed of approximately $\frac{1}{5}$ in. per sec permits a detailed investigation of the fluctuations. This chart is one of several hundred taken during the test. At the beginning of the heat the current is very unsteady, but becomes steadier toward the end of meltdown.

An analysis of this and other charts gave the following values of current swings: Type A load swings (occurring less frequently than one per second) consist of:

A wave with 0.3 to 0.5 maxima and minima per second ± 33 per cent below and above rated current, decreasing to a + 30 per cent and − 15 per cent after 20 to 30 min, then gradually decreasing further. Type B ("cyclic") swings consist of:

A wave superimposed on the carrier, with 3 to 10 maxima and minima, ± 10 to 15 per cent above and below rated current.

These two types of current swings combined influence the line voltage as indicated in Figure 3.

EFFECT OF ARC FURNACE OPERATION UPON POWER NETWORKS

Fluctuations of the arc currents as described in the preceding paragraphs influence the line voltage at any point in the network resulting in variations of the line voltage. The extent of the influence is determined by the impedance involved. Besides variations of the magnitude of the arc currents, changes of the power factor occur at the same time. For example, a short circuit swing may lower the power factor at the furnace bus from a normal 80 to 30 per cent and less, whereas a lesser than normal current may increase the power factor temporarily to 90 per cent and above. Down-swings of the current are associated with a greater degree of harmonic distortion.

In the course of our experiments we can establish the following facts:

1. Current maxima and minima in the three phases are relatively seldom in synchronism. Therefore, the total kva's associated with surges cannot be found by tripling single phase kva swings but are smaller.
2. Current fluctuations do not occur in an abrupt square wave manner. In most cases either the upswing or the downswing, and frequently both, are gradual.
3. As was shown in Figure 3 the intensity of the disturbances gradually diminishes during meltdown, whereas the refining period is not critical at all. Therefore, the disturbances are not of a continuous nature. Operation of two or more furnaces on the same bus shows a distinct levelling-out influence upon the line voltage.

LINE VOLTAGE FLUCTUATIONS AND PERFORMANCE OF LIGHT BULBS

After this brief description of the mechanism of the load swings in electric arc furnaces, the question arises as to what happens to the performance of such sensitive devices as light bulbs when their operating voltage is fluctuating.

The emission of visible light from the filament of a light bulb is a function of the power which in turn depends on the operating voltage. A drop of the line voltage from 100 to 99 per cent results in a decrease of approximately 3.4 per cent of the visible light emission after the filament has adjusted itself to the lower power level. Fluorescent bulbs are considerably less sensitive. Their light emission varies only by approximately 1.5 per cent. The adaptation of the filament to the lower voltage level requires a certain time because the filament has to dissipate its excess.

It is obvious that the thermal inertia given by the diameter of the filament determines the speed of reaction. Small bulbs of the 15 or 25-watt type react much faster than 75 or 100-watt bulbs with their heavier filament. For the same reason fluorescent light bulbs follow line voltage variations almost instantaneously.

The problem of lighting flicker, however, cannot be described just in terms of the physical mechanism encountered in the light bulb. The human element enters the picture in a variety of factors such as, for example, perceptibility, speed of reaction, irritation, etc. Contrary to physical conditions, these factors vary over a wide range and cannot be easily pinned down in figures and formulae. They require a statistical approach.

In the early days of light research it was found flicker can be relatively easily detected by the human eye if it occurs periodically at a frequency between 4 and 7 fluctuations per sec. Unfortunately these frequencies are almost identical with the Type B (or "cyclic") disturbances caused by arc furnaces or arc welders.

In all probability, the human speed of perception in this frequency range is matched with the cycle of occurrence of the flicker such that a sort of psychological feedback condition is established. Below and above this critical frequency range the sensitivity of the eye is less.

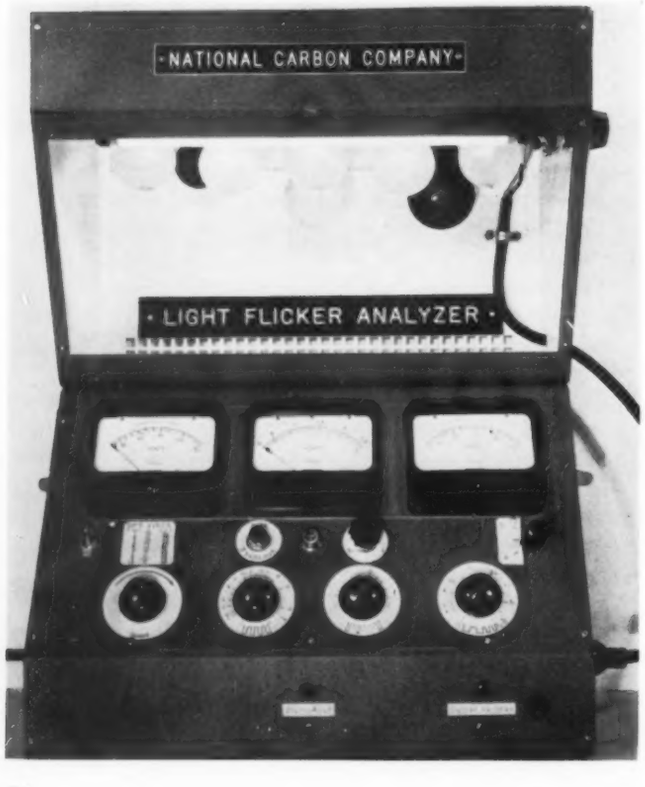
The literature offers a great number of diagrams in which the borderline of perceptibility pertaining to incandescent bulbs in terms of per cent voltage dips is plotted against the frequency of occurrence. In essence the various investigators are in agreement on the critical frequencies in the order of 4 to 7 per sec, with corresponding voltage dips of approximately 0.3 to 0.4 per cent from the rated voltage.

However, the magnitude of voltage dips can be appreciably increased before irritation occurs. In some cases maximum tolerable voltage dips are quoted at 0.45 to 0.55 per cent in the above mentioned frequency range.

NEW LIGHTING FLICKER EXPERIMENTS

In an attempt to review the above borderlines of irritation in the light of our work on furnace arc research we constructed an apparatus which not only delivers cyclic light flicker over the frequency and intensity ranges in question, but also enables us to simulate conditions encountered during critical periods during meltdown of arc furnaces.

Figure 4 — A light flicker analyzer was developed.



This apparatus is shown in Figure 4. It consists of a combination of contactors, series resistors, measuring instruments and a variety of commercially available incandescent and fluorescent light bulbs.

A representative number of persons was investigated as to their reaction to various types of light flicker. This is a summary of our results:

In a preliminary test we tried to verify the existing recommendations for a continuous flicker mentioned above. For this reason we influenced the operating voltage in a square wave fashion (abrupt dips and abrupt increase to the original level of the operating voltage). We found that it is difficult to establish a definite borderline of irritation because the observers reacted very differently to the same condition. It appears that the curves presented in the literature are conservative, and that the per cent voltage dip can be exceeded appreciably before objectionable conditions are reached. The majority of persons investigated initially had no objection to voltage dips appreciably above the aforementioned recommendations. In some cases between 1.2 and 1.5 per cent voltage dip at three to eight cycles per second were accepted. But there were also cases where 0.40 per cent was declared objectionable. It is not without humor that in some cases flicker was detected before the mechanism was in operation.

All observers agreed that low powered bulbs (25 watts) create more disturbances than 60, 75 and 100-watt types. Fluorescent bulbs, although their reaction to voltage changes is much faster, permit considerably larger voltage dips than incandescent bulbs.

As a next step in approaching arc furnace conditions, the test program was modified:

The voltage dips, in accordance with the previously mentioned structure of arc current surges, were no longer of the abrupt square wave type, but decayed gradually. At the end of the dip, the voltage jumped to its original value instantaneously. The result of this series proved that the borderlines or irritation move up to a minimum of 0.8 per cent for 40-watt and 0.95 per cent for 100-watt bulbs. This is shown on Figure 5.

SIMULATION OF MELTDOWN CONDITIONS

As a final step in simulating arc furnace conditions we developed, after a careful analysis of high-speed current oscillograms, a program of disturbances which consisted of one deep dip followed by 5 shallow dips. This is a fair approximation of the effects of current swings erratically occurring during meltdown.

The full operating cycle requires 3 sec and consists of:

(1 deep + 5 shallow dips)	during 1 sec
(1 deep + 5 shallow dips)	during 2 sec
Full line voltage undisturbed	during 3 sec

The magnitude of the voltage dip is adjustable from 0 to 3 per cent for Type A and 0 to 2 per cent for Type B. During the test the shallow Type B dips were adjusted to one-half of the Type A dips in accordance with the analysis of arc current charts.

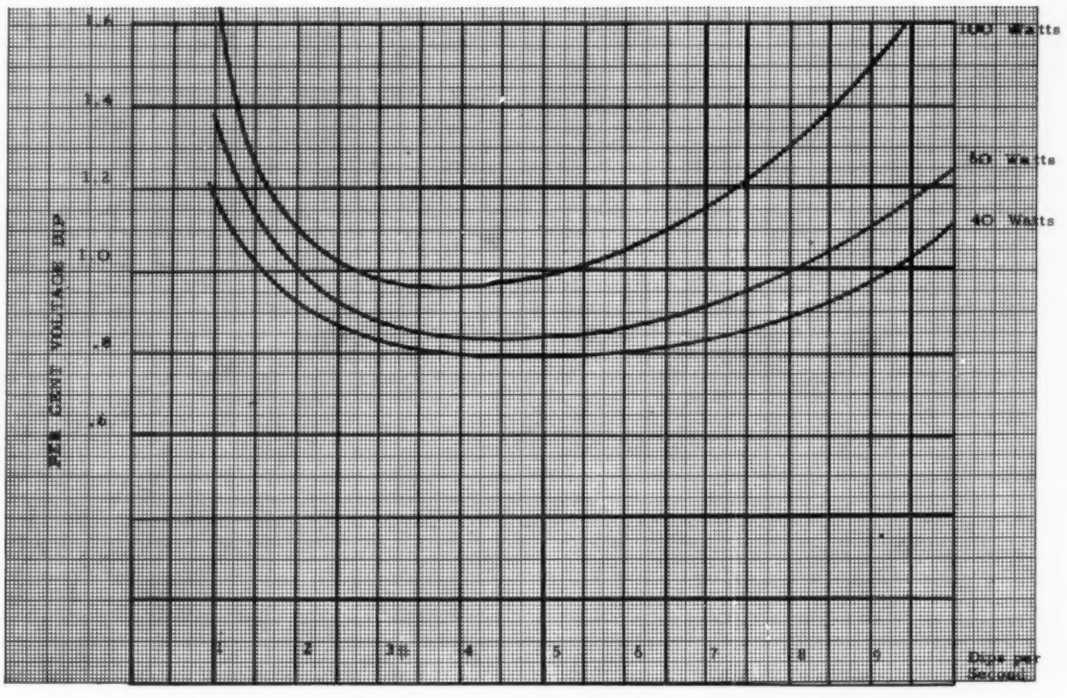


Figure 5 — Border lines of tolerable lighting flicker are given by chart.

Again a wide range of perception and irritation was found among the various observers. It appeared that the one second relaxation period in the program contributed to a fairly high limit of objectionable flicker (Type A 1.4. . .1.6 per cent, Type B 0.7. . .0.8 per cent.

We believe that this machine can be a useful tool in judging and predetermining the degree of interference of newly planned furnaces with their power systems.

REDUCTION OF LOAD SWINGS AND LIGHTING FLICKER

As was shown in paragraphs II and III load swings and line voltage disturbances are caused by unsteadiness of the arcs. In our research and development work we concentrated on this problem not only from the standpoint of lighting flicker but also from the standpoint of improved furnace efficiency since these two things go hand in hand.

We found that the furnace arc during the erratic meltdown period can either be influenced by chemicals acting as arc supporters or by the structure of the electrode tip, or by a combination thereof.

It was found, for example, that a small amount of burnt lime in the arcing zone at the start of meltdown considerably improved the steadiness of the arc.

Hollow electrodes with their funnel shaped tip tend to focus the arc under the tip and reduce erratic arc flare. Electrodes with built-in arc supporting cores or with neutral cores of carbonaceous composition which tend to form a cup shaped tip showed better arcing conditions than regular electrodes.

We investigated the merits of hollow electrodes in quantitative terms in comparison with regular solid electrodes in the trade. It became evident that undesirable current fluctuations are partly influenced by the type of scrap and other variables. Therefore, it was necessary to obtain average results over a sufficient number of heats. Quantitative evaluation of oscillograms and high-speed charts proved to be too tedious and impractical. We needed a more practical yardstick to measure arc behavior and developed a device called load swing analyzer. It consists of a number of electronic pulse counters which count deviations from the operating current at a rate of up to 16 per sec. One counting channel was set to register swings between 110 and 125 per cent counting Type B disturbances. A second channel covered the range of the more intense Type A surges of 133 per cent and above the average operating current. (Load swings below the average current also have been counted.) This technique has been proved to be very practical especially in comparative studies.

Table 1 shows as an example the load swing encountered in the center phase of a 140-ton furnace during the first 30 min of meltdown on the cold scrap (average over 20 heats with solid and hollow electrodes). Similar results were obtained in the other two phases. It is quite evident that hollow electrodes cause less load swings of both Type A and Type B. Furthermore it is significant that their rate of decay with time is in favor for hollow electrodes as indicated by the ratio between the last and first 5 min intervals. Electrode travel and regulator action was also reduced. Other advantages of hollow electrodes associated with the improved arc steadiness has been described previously.

INFLUENCE OF FURNACE SIZE UPON LOAD SWINGS AND LIGHTING FLICKER

The trend in furnace design is distinctly directed toward larger units with correspondingly higher transformer capacities and higher tap voltages. Therefore, the question arises as to the influence of increased capacities on load swings.

In connection with this problem it should be stressed that the nameplate rating of the transformer is not a very reliable basis for comparisons between installations. In numerous cases, the nameplate kva-rating is not identical with the actual average kva-load during meltdown. Furthermore, this method does not account

TABLE I

Surges of Center Phase Current During 30 Minutes of Meltdown of a 140-Ton Furnace 475-Volt Tap

Time interval after start of meltdown, min	Number of surges exceeding 125 per cent of average current (type A swings)		Number of surges between 110 and 130 per cent of average current (type B swings)	
	Electrodes		Electrodes	
	Solid	Hollow	Solid	Hollow
0-5	150	86	730	542
5-10	121	60	703	536
10-15	69	32	603	502
15-20	69	53	615	475
20-25	90	53	692	330
25-30	89	30	518	320
Total	588	314	3861	2705
Average per min	19.4	10.5	129	90.5
Average per sec	0.324	0.175	2.15	1.58
Per cent ratio hollow to solid	54		74	
Ratio between last and first 5-min interval (rate of decay)	0.59	0.35	0.71	0.59

for the unbalanced condition inherent to all furnaces of conventional design.

The operating currents in the three phases, which should be tuned to optimum performance, offer a better criterion.

Our experiment with furnace arcs covering the range from 500 to almost 50,000 amp show that there is no basic difference as far as the structure of load swings is concerned.

Figure 6 shows a comparison of the load swing activities encountered in the center phase of a 70-ton furnace (360-volt high tap) and in the above mentioned 140-ton furnace (475-volt high tap). Both furnaces were operated with current setting close to optimum with power factors of 77 to 79 per cent. Scrap conditions as well as the electrode regulator system were identical at both furnaces.

The x-axis gives the current on a percentage basis with the optimum operating current at the 100-per cent mark for both furnaces. The x-axis shows the average number of load swings per minute during the entire meltdown period obtained as averages from a representative number of heats. The various curves show the envelope of load swings above and below optimum current for hollow and solid electrodes.

It is very interesting that the larger furnace on a percentage basis operates quieter than the smaller one. This is true for the large Type A swings and for the smaller but more frequent Type B swings. It is very likely that the effective arc length or with other words the tap voltage is the governing factor. The larger gap between electrode and melt in the case of the larger furnace is less influenced by random turbulence of the melt than the shorter arcing gap in the smaller furnace. In addition the higher energy level in the arcs of the large furnace provides for better and steadier current conduction.

SUMMARY

Summarizing our experimental findings on the problem of lighting flicker caused by electric furnaces we can state:

1. Erratic changes of the arc length are the cause for current swings during meltdown. In essence two types of current swings occur: (Type A) current swings of a large magnitude and low frequency of occurrence (less than one per second); (Type B) current swings of smaller magnitude but higher frequency of occurrence (3 to 8 per sec). Both types exist in small and large arcs.

2. The degree of disturbance in networks depends on the relation between furnace load and stiffness of the power system.

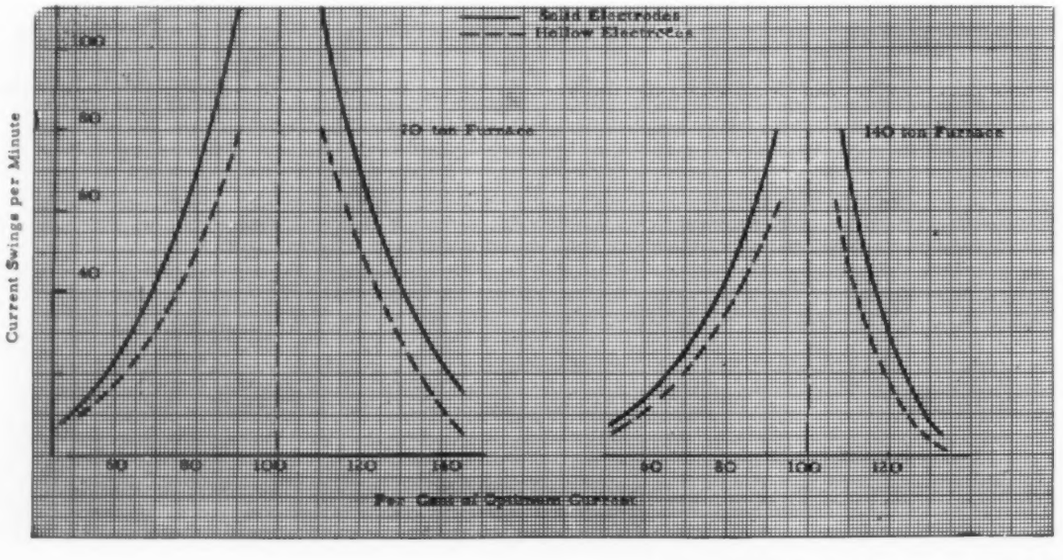


Figure 6 — Load swing analysis of a 70-ton and 140-ton furnace during the entire meltdown period shows smaller variation in larger furnace.

3. On a per cent basis, large furnaces with high tap voltage operate quieter than medium size furnaces with lower tap voltages.

4. Hollow electrodes, cored electrodes providing cup shaped tip and electrodes with arc supporting cores reduce load swings appreciably, however, at an increased rate of consumption.

5. Sensitivity of incandescent light bulbs for voltage fluctuations decreases with increasing wattage rating of the bulb.

6. Improved techniques and better simulation of arc furnace voltage flicker indicate that the present borderlines of tolerable voltage fluctuations can be raised to a somewhat higher level.

Discussion

PRESENTED BY

L. G. LEVOY, Senior Engineer, Industrial Power System Engineering, General Electric Co., Schenectady, N. Y.

W. E. SCHWABE, Product and Process Development Laboratory, National Carbon Co., Div. of Union Carbide Corp., Niagara Falls, N. Y.

N. J. ROBERTS, Engineer, Electric Power Contracts, Republic Steel Corp., Cleveland, Ohio

E. J. BORREBACH, Electrical Engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.

THOMAS J. BLOODWORTH, Chief Systems Engineer, Allis Chalmers Mfg. Co., Milwaukee, Wis.

L. G. Levoy: For many years everybody has been talking about arc furnace flicker and much thought and effort has been given to power system design to minimize the effects of large furnaces on system voltage, but relatively little work has been done to stabilize the arc furnace itself. Mr. Schwabe is therefore to be commended on his effort in this field of endeavor.

Some power companies have been concerned about the growth of the arc furnace industry, and the threat of larger furnaces. Mr. Schwabe's results indicating that larger furnaces with higher secondary voltages tend to be more stable both on Type A and Type B flickers should dispel some of this concern.

Both the Type A and Type B flickers are aperiodic, and since the so-called "cyclic flicker" is faster than the "extremely frequent flicker" these latter terms lead to confusion. New definitive terminology should be developed and Mr. Schwabe has taken a forward looking step in this direction.

Our observations confirm the fact that large furnaces are in general more stable than small furnaces. Referring to Figure 3 of the paper, we note that the recorder input has apparently been rectified and filtered to eliminate the recorder response to the individual cycles. We normally do not use such an input network because it slows down the speed of response. We realize that the chart gets more difficult to read when the pen motor responds to individual cycles. Would Mr. Schwabe comment on the time constant of the input network used?

W. E. Schwabe: As Mr. Levoy indicated, rectification and filtering of current signals is quite a problem. Our recorder presents on paper readings that an ammeter with great response would give. Instead of using an oscillograph, for example, a string oscillograph which gives essentially the peak values, we rectified the current signals and we designed a filter which gives faithful results to about 14 to 15 dips per sec. A great number of electronic components were required for this filter. We can say that up to 14 or 15 dips per sec, the record is accurate within plus or minus one per cent.

N. J. Roberts: We recently had some tests on a large furnace, tests run by the power company with an oscillograph, which tend to confirm to some extent the theory that Mr. Schwabe has presented regarding the magnetic flare of the arc. Strangely—and I think contrary to what most of us have always believed—the most annoying flicker did not occur during the initial stages of the meltdown. The cyclic flicker with a frequency of about four dips per second came at a time when the power input as measured by meters, a wattmeter, varmeter, and so forth, was very constant. Looking at the high-speed meters, you would think it was a very stable arc. And yet at that time, flickerwise, it was the most annoying because of its regular cyclic character.

I would like to ask about the counter that Mr. Schwabe referred to. If I understand it, you are counting the number of swings above a certain value and below a certain value and I am wondering whether that is any indication, or a good indication of the amount of flicker that might result because actually the flicker depends on the starting point of those swings. If you are starting a swing to 125 per cent of normal current, from 100 per cent, that is one thing; if you are striking an arc from zero current, that is something entirely different.

Another thing that I think might be mentioned is the fact that flicker as observed on a light bulb is a far different thing than flicker observed on a television set. I have seen tests with similar machines to this where a television set was plugged in and dips of various magnitudes at different frequencies, were produced with a great deal more annoying results than we get from a lamp bulb of any kind.

W. E. Schwabe: We made similar observations on several occasions where we noticed that this Type B flicker occurred every once in a while after the bulk of the scrap was melted. This could be explained as the result of a fairly uniform agitation of the melt surface. The surface waves of the melt were traveling back and forth. Evidently the diameter of the metal pool, the viscosity of the melt and the action of the arcs created a temporary resonance condition. This condition could be upset by changing the operating currents.

Our load swing analyzer consists of four counting channels each of which is preset to a certain level of arc current.

Since the subdivisions are rather coarse this method is more of a statistical nature, however in our opinion it is much more practical than to evaluate miles of high-speed paper charts or oscillograms.

N. J. Roberts: Another factor enters into it, it seems to me there is a difference between the swings that occur during the initial meltdown, and those occurring after a pool is formed. The resistance is naturally going

to be higher, during initial meltdown because the arc consists of a large number of small arcs flashing from one piece of scrap to the other, and at that particular time, while the kva swings may be large, I am inclined to think they are at a higher power factor and cause less voltage drop. Of course, it is really the reactive swings that cause the flicker because reactance is a much larger element in a power system.

W. E. Schwabe: The distribution of swings as to their kvar or kw magnitude can be very easily evaluated by means of the furnace characteristic, a diagram where primary arc power, the kva's, and kilovars, are plotted against the current. The primary kilowatt curve has a maximum, and the furnace should be operated with currents somewhat below this point. On the right side of the maximum toward larger currents there is a greater magnitude of kilovar swings than on the left side.

As far as television receivers are concerned we found that the design of filters used for the d-c, B-voltage supply is of great importance for their sensitivity to line voltage variations. In other words, sets with low microfarad ratings in the filter are more sensitive than sets with larger condensors. Furthermore, receivers equipped with constant voltage transformers are less susceptible to line voltage flicker.

Confirming Mr. Robert's observations we found that some TV receivers were somewhat more sensitive to voltage dips than light bulbs. Unfortunately our contacting machine which simulates voltage flicker, also influenced the TV receiver via high frequencies caused by sparks in the contact mechanism. Although we used several commercially available line filters, we were unable to fully separate this HF effect from the influence of the line voltage variations.

E. J. Borrebach: The present policy of many power companies concerning flicker seems to be that cyclic flicker rises mostly from large furnaces having ratings above 15,000 kva. By cyclic flicker is meant variations that occur at a rate greater than one per second.

As brought out earlier this year, in AIEE Transactions Paper 57-9 "Survey of Arc Furnace Installations on Power Systems" by Systems Planning Subcommittee, electric utilities have considered smaller furnaces to be capable of producing voltage variations only of the occasional type and of the extremely frequent (one per minute to one per second) type.

Have you found in your studies that there is a cyclic flicker arising besides the Type A or occasional flicker on small furnaces, let us say of 3000 to 5000-kva rating where arc currents range from 5000 to 15,000 amp? If so, it would appear that the power companies would want to take more exception to such furnaces going on their lines because the annoyance factor of cyclic flicker is quite high.

W. E. Schwabe: During our laboratory and field tests we found that there is no basic difference between small arcs of 500 amp and large arcs up 50,000 amp.

We also have studied arc current and arc voltage oscillograms by way of Fourier analysis, and there is no indication that high amperage arcs differ qualitatively from medium or low amperage arcs. The disturbance in the network is just a question of short circuit capacity of the network against furnace load.

Thomas J. Bloodworth: Complaints due to light flicker and television caused by electric furnace operation can be very annoying. We recently encountered a much more serious effect from voltage flickers.

Some time ago, we supplied electrical equipment for a small hot metal furnace where the power line was also connected to a hospital. Even though there was no meltdown period a cycle disturbance affected x-ray photography and treatments at the hospital.

The cyclic flicker had a very regular period, and was continuous, with a constant peak amplitude. This disturbance was finally eliminated by a change in furnace operation—changing the slag composition and consistence caused the cyclic flicker to disappear completely.

W. E. Schwabe: From Mr. Bloodworth's comments it can be concluded that a hydrodynamic resonance condition of slag and melt had existed causing load-swings similar to those described by Mr. Roberts. Changing the slag composition probably resulted in a change of viscosity which in turn eliminated this resonance. ▲

CURRENT AISE DISTRICT SECTION MEETING NOTICES

LOS ANGELES SECTION

Monday, September 8, 1958—Social Hour 6:15 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Card Programming The Modern Mill," by E. H. Browning, Manager, Metal Working Section, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

Michael's Restaurant, 6309 E. Washington, Los Angeles, Calif.

ST. LOUIS SECTION

Wednesday, September 17, 1958—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

Inspection Trip: The New Continuous Butt Weld Tube Mill, Laclede Steel Co., Alton, Ill.
Dinner and Meeting, Stratford Hotel, Alton, Ill.

SAN FRANCISCO SECTION

Friday, August 22, 1958—Social Hour 6:30 P.M., Dinner 7:30 P.M.

Golf Party (A.M. starting times).

Peninsula Golf Club, San Mateo, Calif.

Tuesday, September 16, 1958—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Thermit Welding," by E. B. Russell, Assistant to Superintendent Mechanical Shops, Kaiser Steel Corp., Fontana, Calif.

Shattuck Hotel, Berkeley, Calif.

UTAH SECTION

Monday, September 8, 1958—Social Hour 6:30 P.M., Dinner 7:30 P.M., Meeting 8:30 P.M.

"Future of Industry in Utah," by Honorable G. D. Clyde, Governor of the State of Utah.

Grand View Cafe, Provo, Utah.

1958

ANNUAL CONVENTION
and
IRON AND STEEL EXPOSITION

ASSOCIATION OF IRON AND STEEL ENGINEERS

CLEVELAND PUBLIC AUDITORIUM

CLEVELAND, OHIO

September 23, 24, 25, 26

TO THE MEN OF THE STEEL INDUSTRY:

The constant inflation of production costs in the steel industry has placed a premium on cost-cutting ideas. Such ideas will be yours for the taking at the 1958 Annual Convention and Iron and Steel Exposition in Cleveland, September 23, 24, 25, 26. AISE is happy to be able to offer these opportunities to the men from the iron and steel and allied industries.

This year, the level of steel operations makes it easier for key men of the industry to take the time to attend these functions. We hope you and your men will take advantage of the educational refresher provided in the technical sessions and in the exhibits of the industry's suppliers.

Remember, there is no registration fee and AISE membership is not essential.

Leonard Larson
President, AISE

PREVIEW

IRON AND STEEL EXPOSITION

AISE

ANNUAL CONVENTION

The 1958 Iron and Steel Exposition in conjunction with the Annual Convention of the Association of Iron and Steel Engineers presents an unparalleled opportunity for steel industry men to keep abreast of advancing technology and improved equipment.

Four complete halls will be filled with the latest developments of the leading suppliers to the iron and steel industry. No other exposition offers this concentration of products specifically designed for steel industry use. Every exhibit will be keyed to the needs and applications of steel mill requirements. A day at the Exposition is an education in itself.

Four full days of technical sessions will cover the complete field of steel mill operations, engineering and maintenance. Leading technical authorities will present the very latest thinking on steel industry subjects. A detailed program appears on pages 4 and 5.

Steel mill men from foremen to top level supervision can obtain a "technical refresher course" at the Convention and Exposition that will definitely assist them in the performance of their job. About 14,000 men will take advantage of this opportunity. Many of these men have stated that they never fail to obtain "at least one good idea to increase production or cut costs" while attending.

Tickets for the 1958 Iron and Steel Exposition are being distributed throughout the iron and steel and allied industries. They may also be obtained upon request to the Association of Iron and Steel Engineers, 1010 Empire Building, Pittsburgh 22, Pa. AISE membership is not required and there is no registration fee for the Exposition or the technical sessions.

Iron and Steel Exposition Hours

September 23—Tuesday, 10:00 am - 10:00 pm
September 24—Wednesday, 10:00 am - 10:00 pm
September 25—Thursday, 10:00 am - 5:00 pm
September 26—Friday, 10:00 am - 4:00 pm

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NO REGISTRATION FEE

Transportation

For those not using trains or planes and not wishing to drive, arrangements have been made with the Greyhound Bus Co. to provide charter service for groups or companies.

Details and rates can be obtained from your local Greyhound Agent.

Every man registering at the Iron and Steel Exposition will be given one free chance on a Ford Thunderbird.

Technical sessions will offer the thinking of authorities on the engineering and operating of iron and steel plants.

A regular feature of the Convention is the annual dinner, which will be held in the ballrooms of Hotel Statler.

In no other place is there such a concentration of equipment and product displays of interest to the iron and steel industry . . . .

. . . . and in no other place is there such a concentration of steel industry personnel looking for new ideas.

PROGRAM

1958 AISE CONVENTION and IRON AND STEEL EXPOSITION

CLEVELAND PUBLIC AUDITORIUM

CLEVELAND, OHIO

Tuesday, September 23

9:00 am—REGISTRATION—Main Lobby

9:15 am—BUSINESS MEETING—Ballroom

Conducted by President Leonard Larson

9:30 am—ELECTRICAL SESSION—Ballroom

Chairmen: J. A. Drgon, Division Superintendent, Maintenance and Utilities, Edgar Thomson Works, United States Steel Corp., Braddock, Pa.
B. R. King, Assistant Superintendent, Electrical Dept., Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

"Industrial Telemetering Systems," by Charles D. Close, cdc Control Services, Inc., Hatboro, Pa.

"Power Dispatching in a Steel Mill," by C. L. Eichenberg, Assistant Superintendent, Electrical Dept., Bethlehem Steel Co., Bethlehem, Pa.

"Design Concepts and Electric Drive Systems for Reversing Hot Mills," by R. W. Kirkland, R. E. Marrs, Systems Application Engineers, Engineering Section, and W. E. Miller, Manager, Metal Rolling and Processing Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

9:30 am—SINTERING SESSION—Club Room B

Chairman: W. O. Bishop, Superintendent, Plant 2, Blast Furnaces, Inland Steel Co., East Chicago, Ind.

"New Screening and Sinter Plant Facilities—Inland Steel Co.," by William O. Bishop, Superintendent, Plant No. 2 Blast Furnaces, and C. P. Frame, Assistant Superintendent, Sintering Plants, Inland Steel Co., East Chicago, Ind.

"Layout and Design of The Ashland Sintering Plant," by Richard W. Adams, Area Engineer—Blast Furnaces and Foundry, Ashland Works, Armco Steel Corp., Ashland, Ky.

"Weirton No. 2 Sinter Plant," by G. W. Watson, Superintendent, Sinter Plants, Weirton Steel Co., Div. of National Steel Corp., Weirton, W. Va.

"J&L's Cleveland Works Sinter Plant," by K. S. Loofboro, Superintendent Blast Furnaces, Coke Ovens and Docks, Jones & Laughlin Steel Corp., Cleveland, Ohio.

2:00 pm—COMBUSTION SESSION—Club Room B

Chairmen: W. M. Bloom, Fuel Engineer, Allegheny Ludlum Steel Corp., Brackenridge, Pa.
E. W. Fitch, Chief Combustion Engineer, Republic Steel Corp., Youngstown, Ohio.

"Monolithic Refractory Constructions in Steel Plant Equipment—Plastic and Castable Refractories Compared," by George D. Cobaugh, Manager Specialty Sales, and Charles D. Hauth, Technical Sales, Harbison-Walker Refractories Co., Pittsburgh, Pa.

"Controlling Oxygen and Moisture to a Blast Furnace," by J. L. Wallace, Foreman, Steel Works Fuel Dept., Weirton Steel Co., Div. of National Steel Corp., Weirton, W. Va.

"Opened Coil Annealing—A Steelman's Dream Come True," by Lee Wilson, Chairman of the Board, Lee Wilson Engineering Co., Inc., Cleveland, Ohio.

2:00 pm—MANAGEMENT SESSION—Ballroom

Chairmen: H. L. Jenter, Vice President—Operations, American Steel and Wire Div., United States Steel Corp., Cleveland, Ohio.
L. A. Fugassi, Assistant Chief Engineer, Weirton Steel Co., Div. of National Steel Corp., Weirton, W. Va.

"Incentive Trends in the Steel Industry," by John C. Cramer, Vice President, Albert Ramond & Associates, Inc., Chicago, Ill.

"Controlling Maintenance Costs," by Harold B. Maynard, President, H. B. Maynard and Co., Inc., Pittsburgh, Pa.

"Increased Costs of Production in Steel: The Problem and Possible Solution," by William T. Hogan, S. J., Professor of Economics and Director, Economics Program Fordham University, New York, N. Y.

Wednesday, September 24

9:00 am—ELECTRICAL SESSION—Ballroom

Chairmen: J. F. Kostelac, Assistant Electrical Superintendent, Crucible Steel Co. of America, Midland, Pa.
Richard G. Nolan, Electrical Engineer, Granite City Steel Co., Granite City, Ill.

"Increased Production Through Electrolytic Tinning Line Modernization," by Donald H. Jenter, Application Engineer, Reliance Electric and Engineering Co., Cleveland, Ohio.

"A Modern High Speed Tandem Cold Reduction Tinplate Mill," by Nelson W. Hocking, Jr., Chief Plant Engineer, Wheeling Steel Corp., Yorkville, Ohio, and A. F. Kenyon, Advisory Engineer, Industrial Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

"Modernizing Granite City's Tandem Cold Mill—From a 1946 Model To a 1958 Model in Three Weeks," by A. W. Schlechte, Chief Electrical Engineer, R. G. Nolan, Electrical Engineer, Granite City Steel Co., Granite City, Ill., R. M. Peeples, Supervisory Engineer, Control Dept., and D E. Rea, Application Engineer, Electrical Application Dept., Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

9:00 am—COMBUSTION SESSION—Club Room B

Chairmen: T. J. Harrison, Superintendent of Combustion, Continental Steel Corp., Kokomo, Ind.
R. A. Lambert, Superintendent Steam Efficiency and Combustion, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

"Utilization of By-Product Fuels," by R. W. Worley, Chief Power Engineer, and R. H. Gherst, Senior Power Engineer, United Engineers & Constructors Inc., Philadelphia, Pa.

"Atomization of Open Hearth Fuel Oil with High Pressure Gas," by J. D. Wells, Open Hearth Engineer, and Guy L. Rogers, Works Engineer, Sheffield Div., Armco Steel Corp., Houston, Texas.

"The Twin Pillars of Profit—Blast Furnaces and Power," by Austin E. McDonough, Division Superintendent, Blast Furnaces, and George H. Krapf, Division Superintendent, Power Production, South Works, United States Steel Corp., Chicago, Ill.

Exposition and Technical Sessions are at Cleveland Public Aud

2:00 pm—MECHANICAL SESSION—Ballroom

Chairmen: R. A. Kraus, Superintendent, Mechanical Maintenance, Republic Steel Corp., Chicago, Ill.
S. W. Stouffer, Assistant Director of Construction and Maintenance, Jones and Laughlin Steel Corp., Pittsburgh, Pa.

"Cyclic Welding Method Salvages Heavy Mill Equipment," by R. L. Rectenwald, President, Maintenance Engineering Corp., Pittsburgh, Pa.

"Organizing a Steel Plant Preventive Maintenance Program," by Richard F. Armitage, General Superintendent, Warren District, Republic Steel Corp., Warren, Ohio.

"Cost Estimating—Metal Working Plants," by A. J. Mosso, Executive Vice President, Auburn & Associates, Inc., Pittsburgh, Pa.

2:00 pm—LUBRICATION SESSION—Club Room B

Chairmen: N. A. Bracht, Lubrication Engineer, Alan Wood Steel Co., Conshohocken, Pa.
Robert L. Humphreys, Lubrication Engineer, Mechanical Dept., Bethlehem Steel Co., Sparrows Point, Md.

"Recent Activity Concerning Antifriction Roll Neck Bearing Designs and Mountings," by E. C. Denne, Jr., Manager, Rolling Mill Dept., SKF Industries, Inc., Philadelphia, Pa.

"Maintenance of Mill Oil Bearings," by C. A. Bailey, Lubrication Engineer, National Tube Div., United States Steel Corp., Pittsburgh, Pa., and A. C. Cooper, Superintendent of Roll and Tool Shops, Lorain Works, National Tube Div., United States Steel Corp., Lorain, Ohio.

"An Approach to Wire Rope Lubrication," by Louis A. Stanzione, Engineer, Williamsport Plant, Bethlehem Steel Co., Williamsport, Pa.

6:00 pm—OLD TIMERS' DINNER

Thursday, September 25

9:00 am—ROLLING MILL SESSION—Ballroom

Chairmen: Louis Moses, Mill Engineer, Bethlehem Steel Co., Bethlehem, Pa.
R. P. Schuler, Manager, North Mills, Inland Steel Co., East Chicago, Ind.

"Recent Developments in Pipe and Tube Mill Machinery," by Dieter Hancke, Vice President-Sales, and Robert Hartenstein, Vice President-Engineering, Mannesmann-Meer Inc., Youngstown, Ohio.

"Lone Star Steel's New Stretch-Reducing Mill," by Leonard Eller, Superintendent, E. W. Pipe Mills, Lone Star Steel Co., Dallas, Texas.

"Recent Developments in Design and Control of Hot Strip Mills," by Richard W. Barnitz, Chief Electrical Engineer, and H. H. Shakely, Plants Engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

9:00 am—LUBRICATION SESSION—Club Room B

Chairmen: A. E. Cichelli, Lubrication Engineer, Construction Engineering Dept., Bethlehem Steel Co., Bethlehem, Pa.
E. J. Hochdanner, General Foreman, Maintenance, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

"Considerations for the Application of Fire Resistant Fluids," by C. T. Lewis, Chief Lubrication Engineer, Republic Steel Corp., Cleveland, Ohio.

"Standardization of Lubricants for Steel Mills," by P. D. Metzger, Associate Research Engineer, Lubrications Testing Laboratory, and H. D. Foster, Standards Engineer, Wheeling Steel Corp., Wheeling, W. Va.

"Micro Chemistry in Lubricating Oil Analysis," by F. M. Roberts, Supervisor, Analytical Dept., Texaco Research Center, The Texas Co., Beacon, N. Y.

2:00 pm—OPERATING PRACTICE SESSION—Ballroom

Chairmen: George I. Bottcher, Chief Engineer, Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Warren E. Hart, Superintendent, Electric Furnace Building, Ford Motor Co., Rouge Plant, Dearborn, Mich.

"Perfected and Practical Methods of Processing Powder into Commercial Strip," by Richard A. Smucker, Application Engineer, E. W. Bliss Co., Salem, Ohio.

"New European Developments in Blast Furnace Precipitation," by B. Berg, Manager, Precipitator Division, Ab Svenska Slaktfabriken, Stockholm, Sweden.

"The Strategic-Udy Direct Iron Reduction Process," by Dr. Marvin J. Udy, Vice President, Strategic-Udy Processes, Inc., Niagara Falls, N. Y., and Robert A. Blackburn, Sales Engineer, Koppers Co., Inc., Pittsburgh, Pa.

2:00 pm—FOREIGN SESSION—Club Room B

Chairmen: R. W. Holman, Division Chief Engineer, Tennessee Coal and Iron Div., United States Steel Corp., Fairfield, Ala.
Emil Kern, Vice President in Charge of Engineering, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

"Present Situation of Japanese Steel Industry," by Kichiro Saigo, Manager, New York Office, Yawata Iron & Steel Co., Ltd., New York, N. Y.

"The Venezuelan Steel Works," by M. Gonni, Manager Engineering and Construction Div., Innocenti S.G., Milano, Italy.

"Compania de Acero del Pacifico—Chili, Its Inception and Growth," by Juan Zapata, Vice President, Representative in USA, Compania de Acero del Pacifico, New York, N. Y.

7:00 pm—FORMAL DINNER AND DANCE—Ballrooms

Friday, September 26

9:00 am—COMBUSTION SESSION—Club Room B

Chairmen: David Cousley, Assistant Superintendent, Utilities, Wheeling Steel Corp., Steubenville, Ohio.
C. W. Dunn, Superintendent Utilities, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

"Modern Regenerative Soaking Pits," by Henry S. Hall, Assistant Manager, Combustion Control Dept., Morgan Construction Co., Worcester, Mass.

"Special Features of Stelco's New Soaking Pits," by E. T. W. Bailey, Chief Combustion Engineer, Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada.

"Heating Facilities For Youngstown Sheet and Tube's New Seamless Mill," by F. C. McGough, Superintendent of Fuel and Power, Youngstown Sheet and Tube Co., Indiana Harbor, Ind.

2:00 pm—OPERATING PRACTICE SESSION—Club Room B

Chairmen: W. H. Collison, Plant Superintendent, Blast Furnaces and Coke Plant, Great Lakes Steel Corp., Div. of National Steel Corp., Ecorse, Mich.
Charles H. Good, Jr., Chief Engineer, Central Operations, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

"Electric Arc Furnace Analysis via Photography," by J. A. Brosovic, Senior Project Engineer, Electrical Laboratory, Republic Steel Corp., Cleveland, Ohio.

"Vacuum Pouring for Large Forging Production," by Elliott A. Reid, Assistant Chief Metallurgist, Bethlehem Steel Co., Bethlehem, Pa.

"Nuclear Energy Applications to Steel Plant Operations," by Patrick J. Selak, Manager, Nuclear Engineering Development, and Rudolph Tietig, Jr., Principal Engineer, Steel Plants Div., Kaiser Engineers Div., Henry J. Kaiser Co., Oakland, Calif.

2:00 pm—ELECTRICAL SESSION—Ballroom

Chairmen: Robert T. Lucas, Electrical Superintendent, Weirton Steel Co., Div. of National Steel Corp., Weirton, W. Va.
Clayton L. Squier, Assistant Electrical Superintendent, Bethlehem Steel Co., Lackawanna, N. Y.

"E. O. T. Crane Runway Rail Installations," by W. J. Tunny, Superintendent, Electrical Maintenance, Youngstown Sheet and Tube Co., East Chicago, Ind.

"Design and Performance of Industrial Lighting Systems," by Daniel J. O'Neill, Manager of Industrial Lighting, Holophane Co., Inc., New York, N. Y.

"Protecting Your Cable Investments," by Charles Van Hoy, Rubber Power Cable Engineer, Anaconda Wire & Cable Co., Marion, Ind.

. . . . . **Social Functions are at Hotel Statler** . . .

LADIES PROGRAM

HEADQUARTERS

PARLOR E

HOTEL STATLER

TUESDAY, September 23

9:00 am — Ladies Registration — Parlor E, Hotel Statler
12:30 pm — Social Hour — Pine Room, Hotel Statler
1:15 pm — Luncheon — Euclid Ballroom, Hotel Statler

WEDNESDAY, September 24

12:30 pm — Luncheon — Higbee's Lounge
The Higbee Co. is located on Public Square

THURSDAY, September 25

9:30 to 11:30 am — Kaffee Klatsch — Parlor E, Hotel Statler
7:00 pm — Formal Dinner — Ballrooms, Hotel Statler
10:00 pm — Dance — Euclid Ballroom, Hotel Statler

★ ★ ★

Honorary Chairman — Mrs. Leonard Larson
Honorary Vice Chairman — Mrs. J. N. Evans

General Chairman — Mrs. B. T. Beasley, Jr.
Vice Chairman — Mrs. F. M. Darner

★

To partially cover the cost of ladies' activities, a flat charge of $5.00 will be made, covering everything except the formal dinner. This must be paid on registering, when tickets will be issued for the various events.

HOTEL RESERVATIONS

Arrangements have been made with the various hotels in Cleveland, whereby they have set aside blocks of rooms for the use of those attending the convention and exposition of the Association of Iron and Steel Engineers in Cleveland, Ohio, September 23, 24, 25, and 26.

We suggest that you make your reservation as early as possible, directly to the hotel of your choice. If that hotel cannot take care of you, they will pass your reservation on to the Cleveland Convention Bureau, who will place you elsewhere.

Be sure to state specifically the type of accommodations desired and the time of your arrival.

BIGGER THAN EVER BEFORE IN 1958

IRON and STEEL EXPOSITION

CLEVELAND

September 23, 24, 25, 26

LIST OF EXHIBITORS

A

Adalet Manufacturing Co., The
Ajax Flexible Coupling Co., Inc.
Allen-Bradley Co.
Alliance Machine Co., The
Allis Co., The Louis
Allis-Chalmers Manufacturing Co.
American Air Filter Co., Inc.
American Brake Shoe Co.
American Messer Corp.
American Steel & Wire Div., U. S. Steel Corp.
Anaconda Wire & Cable Co.
Appleton Electric Co.
Ashland Oil & Refining Co., Inc.
Askania Regulator Co.
Atwater Engineering, Inc., K. W.
Automatic Transportation Co.

B

Bailey Meter Co.
Bearing Service Co.
Blaw-Knox Co.
Bliss Co., E. W.
Bloom Engineering Co., Inc.
Buell Engineering Co.

C

Chalfant Manufacturing Co.
Chandeysson Electric Co.
Chemical Construction Corporation
Chromium Corp. of America
Cities Service Petroleum, Inc.
Clark Controller Co., The
Cleveland Crane & Engineering Co.
Cleveland Engineering Society
Cleveland Safety Council
Cleveland Worm & Gear Co.
Cooper Split Roller Bearing Corp.
Crouse-Hinds Co.
Cunningham Co., M. F.
Curry Air Shear Corp.
Cutler-Hammer, Inc.

D

Detrick Co., M. H.
Dowell Incorporated
Dravo Corp.

E

Edison Industries Div. of McGraw-Edison Co., Thos. A.
Electric Furnace Co., The
Electric Storage Battery Co., Exide Industrial Div
Elliott Co.
Elwell-Parker Electric Co., The
Enterprise Co., The
Erico Products, Inc.
Euclid Electric & Mfg. Co., The

F

Fabreeka Products Co.
Farval Corp.
Femco, Inc.
Fenn College
Foote Bros. Gear and Machine Corp.
Foxboro Co., The

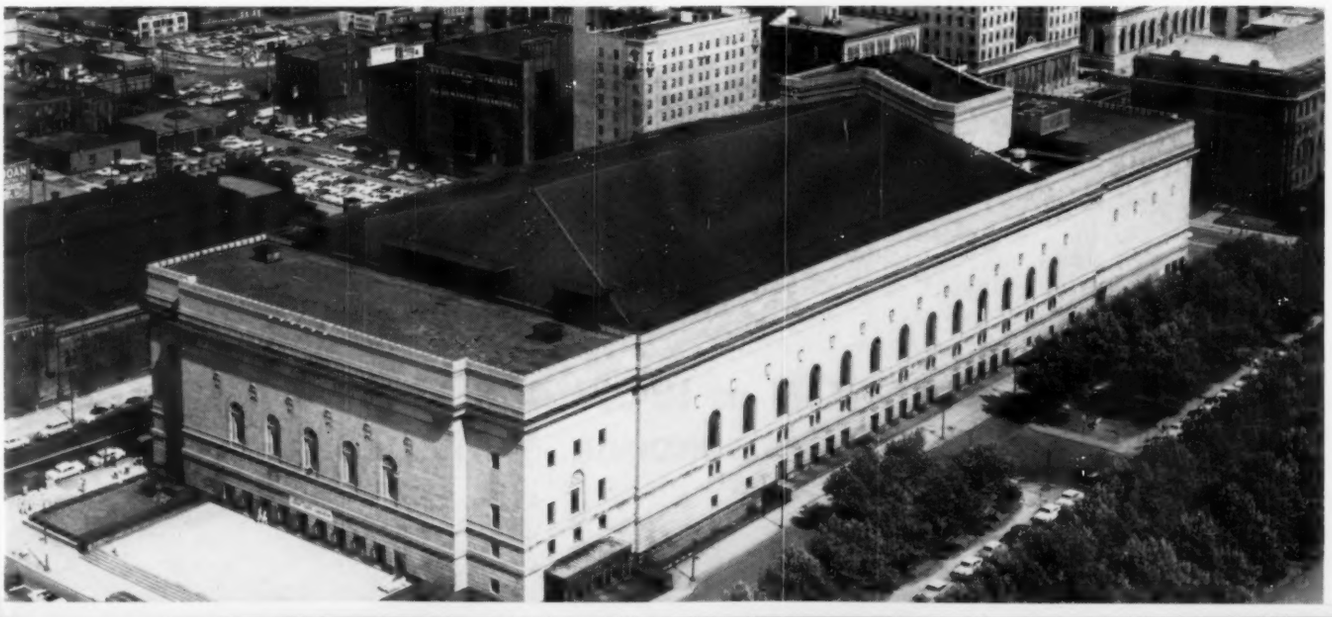
G

Gear Grinding Machine Co., The
General Electric Co., Apparatus Sales Div.
General Electric Co., Distribution Assemblies Dept.
Gleason Reel Corp.
Golden-Anderson Valve Specialty Co.
Gould-National Batteries, Inc., Industrial Div.
Gould-National Batteries, Nicad Div., Inc.
Gulf Oil Corp.
Guyan Machinery Co.

H

Hagan Chemicals & Controls, Inc.
Harnischfeger Corp.
Heil Process Equipment Corp.
Heyl & Patterson, Inc.
Hodson Corp., The

Cleveland Public Auditorium, site of 1958 AISE Convention and Exposition.



LIST OF EXHIBITORS (continued)

Holophane Co., Inc.
Homestead Valve Manufacturing Co.
Houghton & Co., E. F.
Hunt & Son, Inc., C. B.
Hyatt Bearings Div., General Motors Corp.
Hyde Park Foundry & Machine Co.

I

Industrial Gauges Corp.
"Industrial Heating"
Industrial Nucleonics Corp.
"Iron Age, The" - Chilton Co.
Iron Lung Ventilator Co.
I-T-E Circuit Breaker Co.

J

Joy Manufacturing Co., Electrical Products Div.

K

Kinney Engineers, Inc., S. P.
Kolene Corp.
Koppers Co., Inc., Metal Products Div.

L

Larco, Inc.
Leeds & Northrup Co.
Link-Belt Co.
Loewy Hydropress Div., Baldwin-Lima-Hamilton Corp.

M

Magnaflux Corp.
Mansaver Industries, Inc.
Martindale Electric Co., The
McDowell Co., Inc.
McGill Manufacturing Co., Inc.
Mesta Machine Co.
Metal Progress (American Society For Metals)
Mine Safety Appliances Co.
Minneapolis-Honeywell
Modern Sound Co.
Morgan Construction Co.
Morgan Engineering Co., The
Motor Coils Mfg. Co.

N

National Electric Coil Co.
National Safety Council
Nife Incorporated
North American Manufacturing Co., The

O

Ohio Carbon Co., The
Ohio Electric Mfg. Co., The

P

Pangborn Corp.
Pannier Corp., The
Poole Foundry & Machine Co.
Porter Co., Inc., H. K., Delta-Star Electric Div.
Post-Glover Electric Co., The
Pyle-National Co., The

R

Radiant Lamp Corp.
Ramtite Co., The
Ready-Power Co., The
Red Seal Electric Co.
Reintjes Co., Geo. P.
Reliance Electric and Engineering Co.
Republic Flow Meters Co.
Ringsdorff Carbon Co.
Robinson Ventilating Co.
Rockbestos Products Corp.
Rollway Bearing Co., Inc.
Rust-Oleum Corp.

S

Selas Corp. of America
Shell Oil Co.
Simonds Abrasive Co.
Simplex Wire & Cable Co.
SKF Industries, Inc.
Socony Mobil Oil Co., Inc.
Solvent Service, Inc.
Spraying Systems Co.
Square D Co.
"Steel" - Penton Publishing Co.
Sutton Engineering Co.
Swindell-Dressler Corp.

T

Taylor Instrument Companies
Telechrome Manufacturing Corp.
Texas Co., The
Timken Roller Bearing Co., The
Tool Steel Gear & Pinion Co.
Torrington Co., The, Bantam Bearings Div.
Trabon Engineering Corp.
Treadwell Construction Co.

U

Union Carbide Corp.
United States Department Of Commerce
U-S Electric Mfg. Co.

W

Wagner Electric Corp.
Waldron Corp., John
Western Precipitation Corp.
Westinghouse Electric Corp.
Wheelabrator Corp.
Wilson Engineering Co., Inc., Lee
Wing Mfg. Co., L. J., Div. of Aero Supply Mfg. Co., Inc.

Y

Yale & Towne Manufacturing Co., The

Z

Zurn Industries, Inc.

IRON AND STEEL EXPOSITION

CLEVELAND PUBLIC AUDITORIUM

CLEVELAND, OHIO

ASSOCIATION of IRON and STEEL ENGINEERS

1010 EMPIRE BUILDING · PITTSBURGH 22, PA.

by Robert Kyle,
Vice President,
The Gas Machinery Co.,
Cleveland, Ohio

Gas Storage for Peak Demands

Gas storage is obtained through low pressure (water and waterless) and pressure holders, liquid storage or by means of gas generation . . . . data given in this paper will help in selecting right unit for a given set of conditions.

THE capacity and flexibility available in gas storage can solve many of the problems of gas demand with respect to both hourly and daily variations. Figure 1 illustrates a typical hourly load equation occurring with a gas storage holder installation.

GAS HOLDERS

When a problem of gas storage occurs, one thinks logically of gas holders. But various types and sizes of gas holders exist and there are alternate means of effecting gas storage.

To make a choice involves consideration of both engineering and economics. The volume to be stored is the most important single factor, the nature of the gas probably being secondary. One type of holder might be the choice for a small volume of a given gas whereas another form of storage should be selected to handle large volumes of the same gas.

A general classification of service for gas holders might be roughly made as low pressure, intermediate pressure, high pressure, and liquefied gases.

The gas to be stored may be natural gas, coke oven gas, producer gas, blast furnace gas or other fuel gas or ammonia, oxygen or atmosphere gas.

Low pressure holders have historically offered a conventional storage means for gas both in the history of the gas industry and in the steel industry. These are essentially constant pressure holders, with variable volume.

The wet seal holder is the most common type, either as a single lift or as a multiple lift telescopic arrangement utilizing holder "cups." See Figures 2 and 4. Essentially the wet seal holder consists of an inverted steel bell which dips into a steel tank usually containing water so that the bell or holder lift is free to rise or fall according to the amount of gas confined in it. A guide frame is provided to prevent the lift from toppling over and pipes are introduced, usually internally, to carry gas to and from the holder.

The principle of this type of holder was discovered by the great French chemist Lavoisier in 1781. Then used only in the laboratory, it was called and is sometimes still called a gasometer. Originally rectangular, the first cylindrical gas holder, similar to present day construction, was built in 1816–17 by Samuel Clegg of the London and Westminister Gas Light & Coke Co.

For practical reasons, mainly tank size requirement, single lift holders are limited to 100,000 cu ft capacity. At this breaking point, in fact, a two-lift holder is more economical. By telescopic, multiple lift construction, available capacity is extended to 15,000,000 cu ft. The original bell becomes the upper lift with additional lift sections fitted into the tank and being pulled up one by one as additional gas is introduced. An arrangement of grips and cups permits interlocking and at the same time picks up sealing water from the tank.

Variations in diameter and height are, of course, permissible, so that holders are available to industry in many capacities. One manufacturer, for example, offers single lift holders in twelve sizes from 2500 to 100,000 cu ft and multiple lift holders in twenty-five sizes from 100,000 to 15,000,000 cu ft. The large holder is composed of seven sections. For special or test purposes, single lift holders can and are made smaller than 2500 cu ft—there is really no minimum.

The wet seal holders built in this country can be further identified as guide frame holders. In Europe many multiple lift holders are spiral guided and apparently give satisfactory service. In this type, the holder is in effect a coarse threaded screw with spiral rails on the outside of the lifts forming the threads, and guide carriages fixed to the tops of the grips and tank constitute the nut.

Holder pressure is normally 5 to 14 in. water column but can be increased to approximately 25 in. water column by weighting of the holder lifts.

In industry, the sizes most likely to be found would fall in the range of 25,000 to 3,000,000 cu ft. As an example of cost, a 25,000 cu ft single lift holder would be about $40,000 in the Pittsburgh area. A 100,000 cu ft two lift holder would be $90,000. A 1,000,000-cu ft three-lift holder would be $395,000. A 3,000,000-cu ft

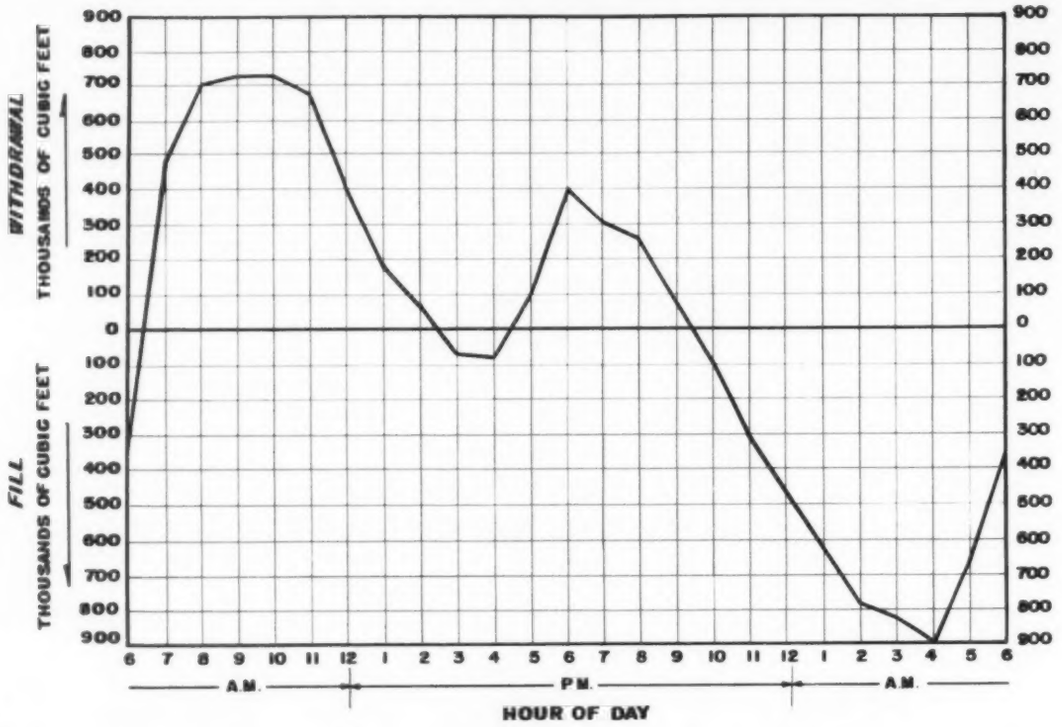
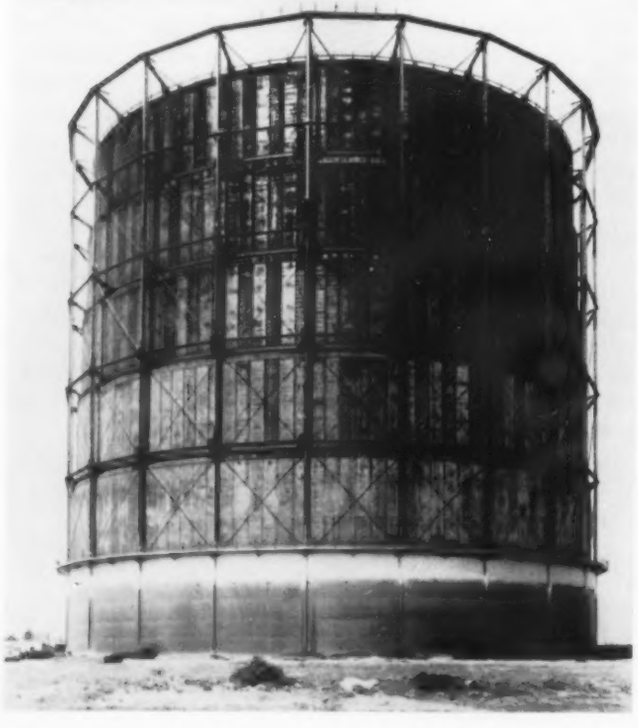


Figure 1 — Typical load equation provided by gas storage holder.

four-lift holder would be $850,000. Prices are delivered and erected, but do not include foundations or painting.

Figure 2 shows an all welded steel holder. With the exception of the top ring of the water tank, the holder was unpainted at the time the photograph was taken and thus the welded steel panels can be identified as well as the welded steel framing. The rated capacity of this particular holder (installed at Long Beach, Calif.) is 5,000,000 cu ft. Figure 3 shows a detail of this holder; in the figure can be seen the connection of the guide frame columns and diagonals at the tank walk with a pair of tangential guide rollers and holder lifts

Figure 2 — This multiple-lift, water-seal, gas storage holder has a capacity of 5,000,000 cu ft.

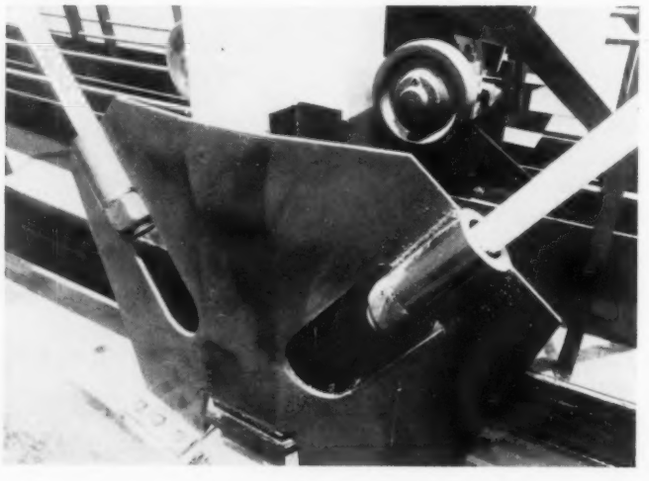


in the background, some of these sections resting in the water tank.

Figure 4 is an illustrative section drawing of the cup and grip arrangement which makes the multi-lift holder possible and provides a water seal between sections as the lifts raise and lower through considerable distances.

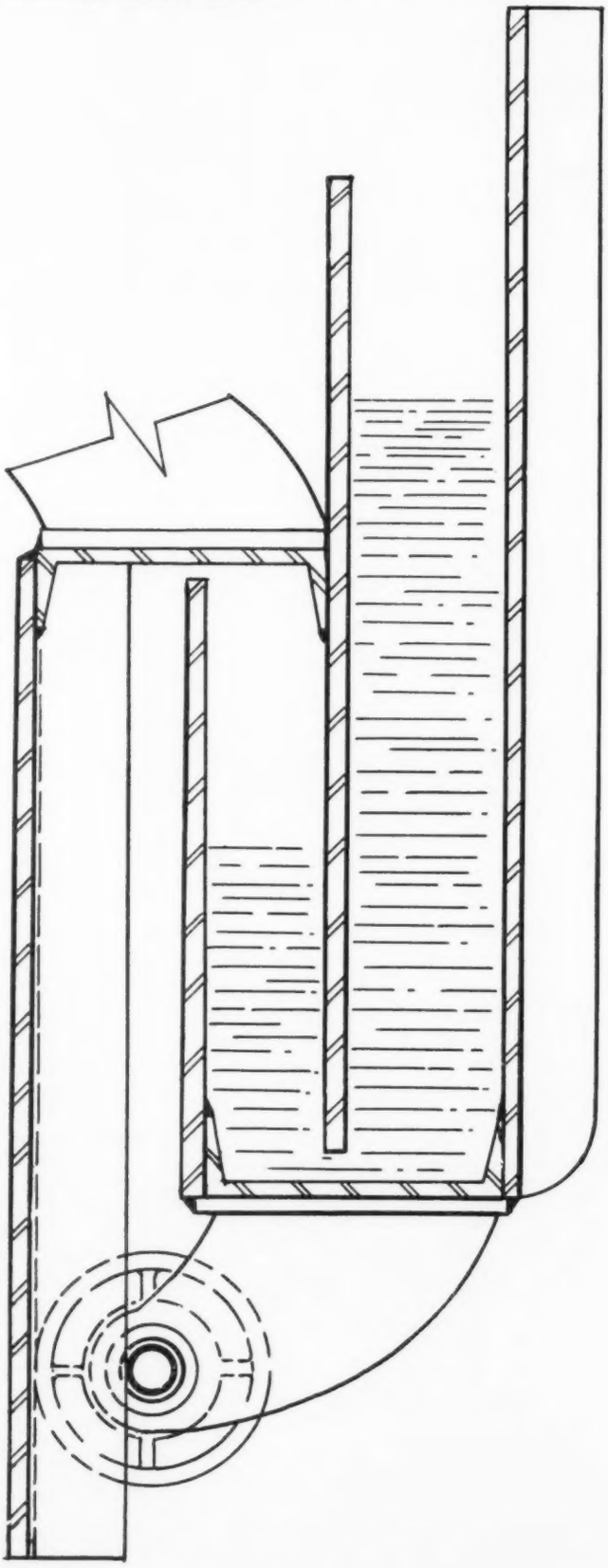
Waterless holders for low pressure service are of somewhat more recent origin. There are two general variations: the piston type and the diaphragm type. The piston type holder was originated in Europe—Germany to be precise—by two separate holder construction companies with two slightly varying arrangements. One of the German companies was Maschinenfabrik Augsburg-Nurnberg A. G. who developed a holder in 1914 usually identified as M.A.N. In this type, the holder shell has a polygonal cross section, the under surface of the piston is a horizontal plane and the joint between piston and shell is made tight by means of a tar seal. The other German builder was August Klonne who in about 1911 patented a con-

Figure 3 — Construction details of welded water seal holder.



struction since identified as the Klonne type. In this arrangement, the waterless holder has a circular cross section, a piston with a crowned under surface and a dry, friction joint between piston and shell. In either case, the piston is the only moving part, rising or falling with intake or discharge of gas, tar being pumped to

Figure 4 — A cup and grip arrangement is used on water-sealed, gas storage holder.



the piston seal of the M.A.N. holder. The piston is trussed and maintained level by guide rollers. The holder shell is the main structure, with a roof overhead, and of course, no water tank is needed. For quite some years piston holders have been built by American companies in both the M.A.N. and Klonne styles. Rated capacities vary from 200,000 to 20,000,000 cu ft. Figure 5 shows a typical waterless, piston style gas holder of the M.A.N. style.

Another form of waterless holder is the diaphragm type, developed about twenty years ago by John Wiggins. The Wiggins holder is actually a combination of piston and diaphragm maintaining a connected and positive seal at all times. In this construction the annular space between cylindrical shell and piston is fitted with a chemically inert fabric composed of woven asbestos glass covered by synthetic rubber. When the holder is empty, the piston is resting on the bottom. As gas enters, its pressure causes the piston to rise, and as more gas is fed in, the piston reaches a position where its peripheral fender contacts the upper girder of the outer telescoping fender (circular girder). From this position to full position, the telescoping fender rises with the piston. Reverse action occurs when the holder is emptied.

Wiggins holders are constructed in sizes ranging from 50 to 1,000,000 cu ft, the 50 cu ft or similar size being, of course, a laboratory model. Holder pressure may be low as 2.5 in. water column and up to 20 in. water column. The higher pressures are obtained by placing concrete weights on top of the piston which practice is also followed for the other types of waterless holders.

Figure 6 is a cutaway illustration of the Wiggins construction. Figure 7 shows a 500,000-cu ft holder built in a steel plant by the General American Transportation Co. for the handling of coke oven gas. Another construction company offers a similar holder but so far in limited sizing.

Compared to the traditional water seal storage

Figure 5 — This welded waterless, piston style gas storage holder has a capacity of 10,000,000 cu ft.

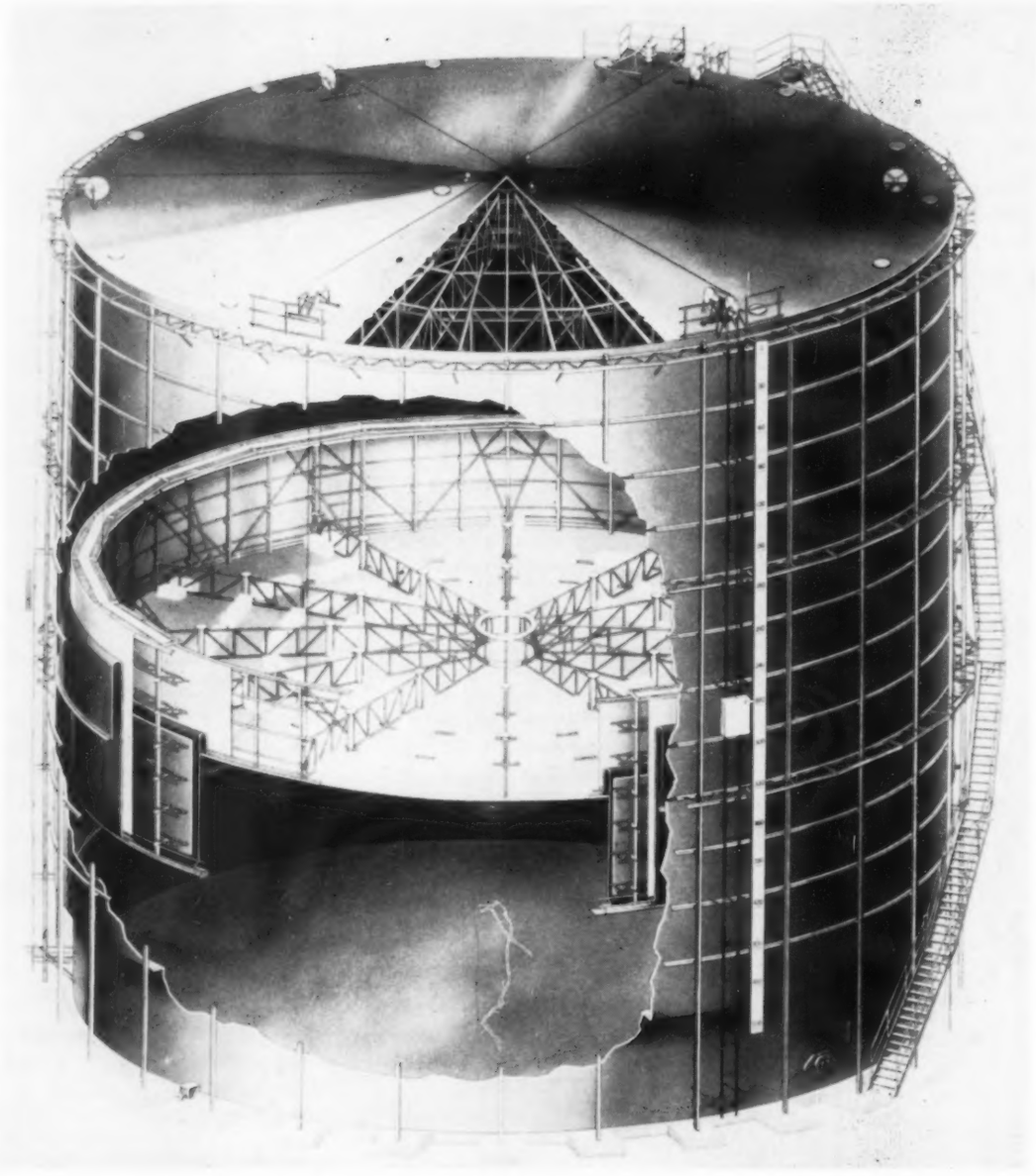


Figure 6 — Cut-away view illustrates principle of diaphragm type gas storage holder.

holder, advantages of the waterless types include less foundation requirement, simpler operation in cold weather, improved appearance, accessibility for inspection and uniform pressure. Nevertheless, water seal lift holders continue to find favor for some applications.

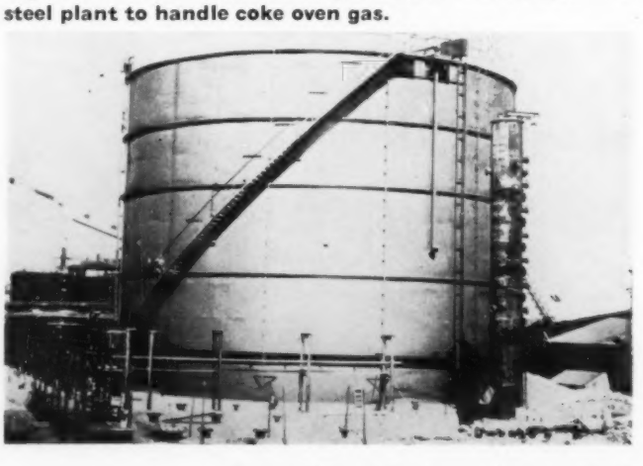
As an example of cost, the Wiggins holder could be constructed for storage of 200,000 cu ft in the Pittsburgh area for approximately $150,000—this price without foundation or painting.

Low pressure holders in general were formerly riveted and are now built in welded steel construction. Present day costs for low pressure storage holders are indicated on the graphs of Figures 8 and 9 for various rated capacities. The prices include, in this case, provision for foundation and painting, gas connections and other items to complete a holder installation and since the costs are approximate, they may be applied to low pressure storage holders of all types.

PRESSURE HOLDERS

Storage of gas under pressure offers advantages in some situations and is particularly applicable where gas is distributed at a moderate pressure higher than could be obtained at the outlet of a low pressure holder without compression. Such gas storage holders have been used for a number of years, were formerly riveted, and are now of all welded steel construction. The total capacity in these holder applications is likely to be under 1,000,000 cu ft referred to standard conditions.

Figure 7 — This 500,000-cu ft gas holder was erected in a steel plant to handle coke oven gas.



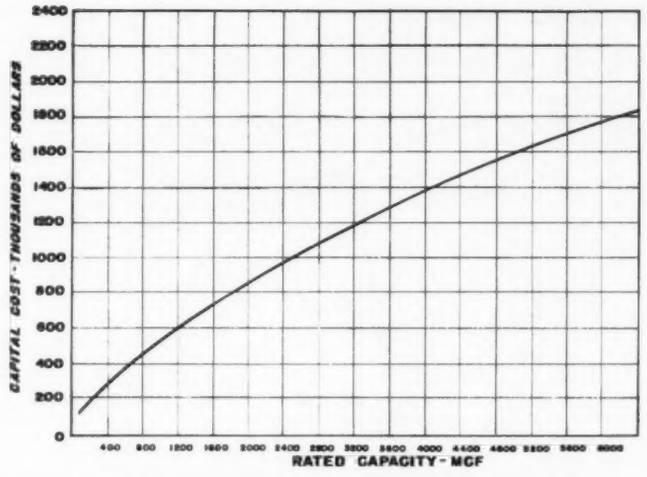


Figure 8 — Capital cost of low pressure gas storage holders.

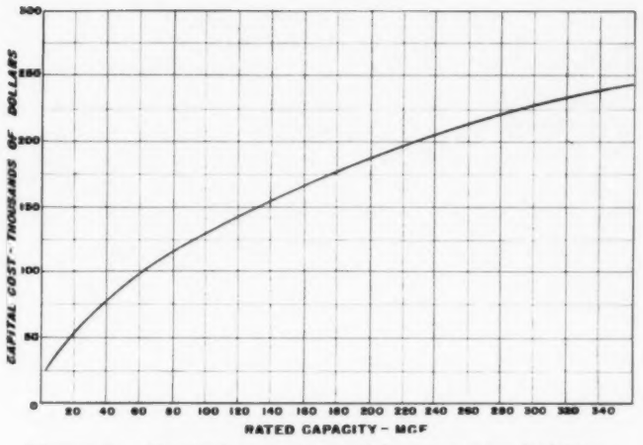


Figure 9 — Capital cost of small low pressure holders.

The usable capacity is determined by the range of pressure from maximum storage pressure to delivery pressure. The practical maximum pressure depends on the volume and construction of each individual storage vessel which is limited to approximately 1 ¼-in. plate. Under these conditions, large volume pressure holders may have a maximum storage pressure of 60 psig, smaller volume vessels up to 100 psig and very small cylinders or bottles at a much higher pressure.

Pressure holders may be built of bullet construction, as spheres, as plain spheroids and as noded spheroids. Choice of construction depends largely upon the capacity desired and the operating pressures.

The "bullet" construction comprises a steel cylinder of substantial diameter with hemispherical ends. The vessel is usually erected horizontally but may be vertical. See Figure 10. Typical sizes would offer such usable capacities as the equivalent of 150,000, 250,000, or 400,000 cu ft. A typical storage pressure range is 15 up to 60 psig with delivery at 15 psig.

Really high pressures can be accommodated by relatively small cylinders or bottles. These may be used singly or manifolded, may be stationary, or portable. See Figure 11. Typical applications are for nitrogen, argon, oxygen, propane, etc. Storage may be as gas liquid for gaseous use. Specific discussion of liquid-to-gas storage applications will appear later in this paper.

For large volume pressure storage, modern day applications are making more and more use of the sphere and the spheroid. The latter may be plain or noded with one or more nodes in roof and bottom (Figure 12). Spheroids can be employed for storage of volatile liquids and for liquefied gases at suitable temperature and pressure.

Figure 13 shows the installation for gas storage of the two largest spheres ever built. These were constructed of T1 steel in Japan and could not have been built in the U. S. under existing ASME code restrictions. The vessels shown are 110 ft-6 in. in diam and at the maximum storage pressure of 71 psig each can deliver the equivalent of 3,420,000 cu ft when released to atmospheric pressure. Actual volume is 700,000 cu ft.

Pressure gas holders may be located at the beginning of a distribution line, at the end or at some intermediate point. When flow rates vary considerably and required line pressures vary accordingly, the holder may simply be "floated" on the line accumulating pressure under high pressure conditions for release under low pressure conditions. With a transmission line as an example, the main demand may occur at the end of the line. Thus the gas holder could be floated at this point to accumulate pressure when the demand is light and release gas direct to feeder branches when demand is heavy. Under other requirements, the installation might be modified by the addition of a small compressor to pump gas from the main, when available, to be released later to meet peak demands.

In other applications, the gas holder may be pressured initially by the main compressor station to supply the entire system.

Figure 14 indicates the approximate cost for high pressure gas storage of various rated capacities. The rated capacity is the equivalent volume when reduced from maximum storage pressure to atmospheric

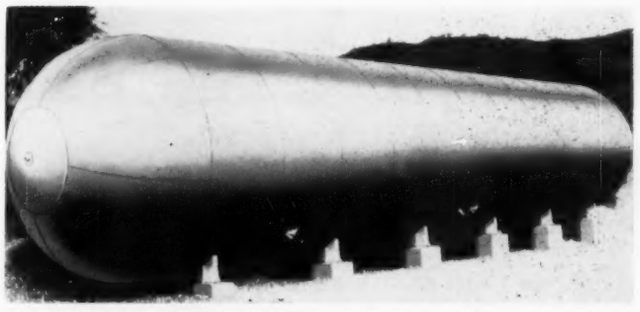


Figure 10 — "Bullet" construction consists of a steel cylinder with hemispherical ends.

Figure 11 — Portable high pressure bottles are commonly manifolded for gas or liquefied gas.

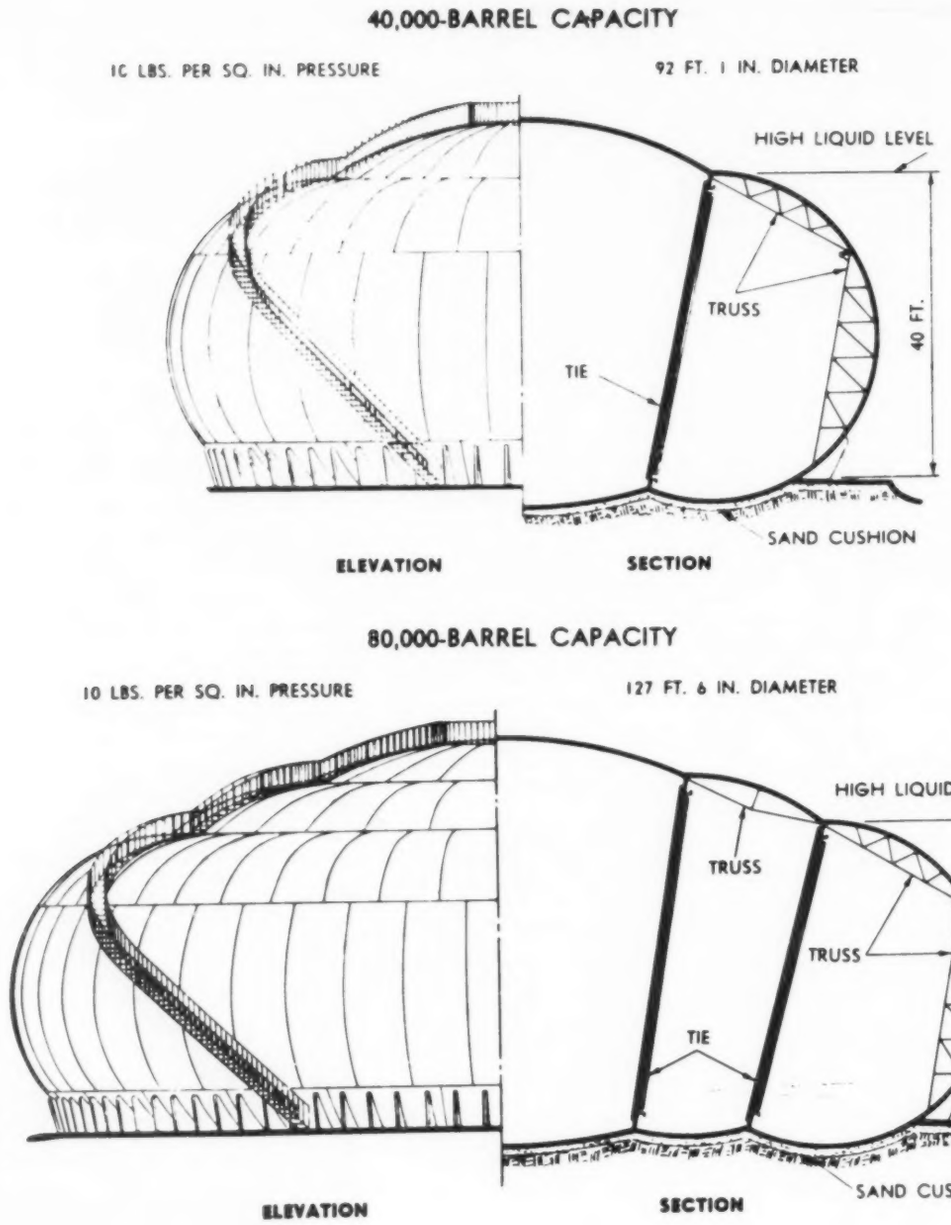


Figure 12 — Spheroids are now often used for storage of volatile liquids and liquefied gas.

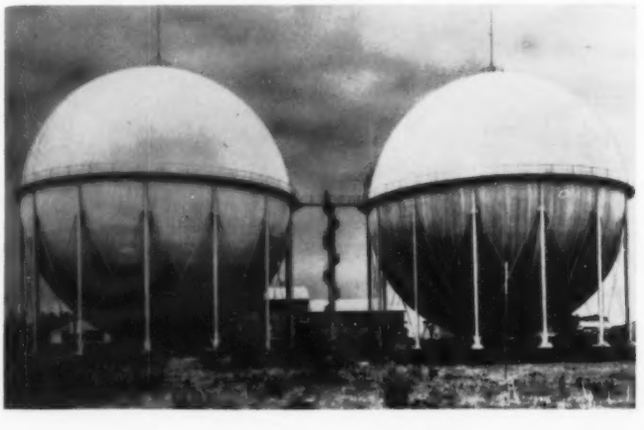
pressure and actual available volume is less, depending upon the actual delivery pressure. Cost provision has been made for foundations, painting and other items to complete the installation, but compressors, if required, are not included in the estimates on this graph.

STORAGE AS LIQUID

A number of gases can readily be stored in liquid form usually under pressure—later released as gases or vaporized. Examples are propane, butane, and ammonia. The most likely fuel gas in this category is propane which is usually stored in horizontal tanks similar to bullets with typical capacities of 30,000 and 18,000-gal water capacity. Net propane liquid will be about 85 per cent of the tank water capacity. Propane storage tanks may, of course, be built in smaller sizes and may even be made as small as 10 gal each for portability. The portable feature is helpful in many applications such as tractors, trucks, for gas cutting, etc.

Delivery of propane fuel gas may be by means of vapor directly from the vapor space of the tank or by transferring liquid propane to a vaporizer. The propane may be employed as a fuel gas in its pure vapor form

Figure 13 — These 3,420,000-cu ft spheres are believed to be the largest ever built of this type.



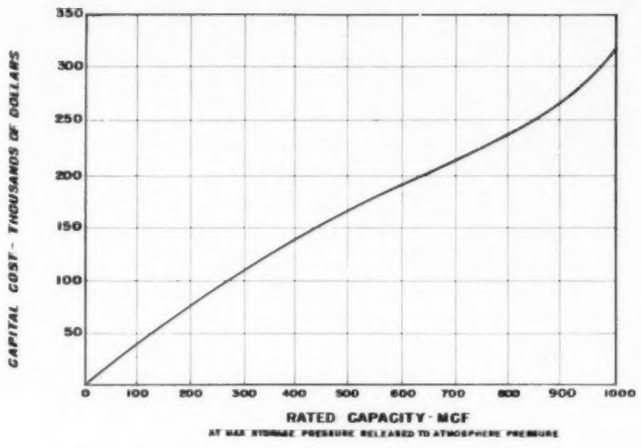


Figure 14 — Capital cost of pressure gas holder.

at about 2500 Btu per cu ft or may be diluted with air to become an equivalent of natural gas or of other gases. Figure 15 is a typical flow diagram of one method for storing, vaporizing, and mixing propane for industrial gas use. Storage and handling of ammonia is quite similar.

Newer storage methods are being offered for large volume storage of propane. One of these involves refrigeration with storage at comparatively low pressure. Another and larger volume method recently employed, is the use of underground caverns, which caverns are man made.

Figure 16 shows the related refrigerating and handling equipment, for insulated and refrigerated tank for storage of liquid propane at low pressure. Propane itself serves as the refrigerant. This novel and attractive installation was designed and constructed for the Atlanta Gas Light Co. The tank, has a capacity of 1,300,000 gal of liquid propane, equivalent to approximately 130,000,000 cu ft of natural gas.

Among the possible liquid gases can be included natural gas, since it is technically possible to liquefy methane and ethane and this has actually been done. The method has been proposed for several pending large scale utility and industrial applications.

In addition to caverns for storing liquid propane underground, there are other underground arrangements which have been used. The gas industry, for example, has been making extensive use of depleted gas wells, which is the preferred arrangement, and also of similar underground structures such as salt domes. Another scheme, and one which might be applicable to industry, is the installation of high pressure "bottles" at 2000 to 2240 psig, making use of super-compressibility. These bottles are interconnected and are laid in the manner resembling high pressure gas lines.

A similar form of underground storage is the use of line pipe at about 1,000 to 1,500 psig. Such bottles are piped, installed below the surface of the ground in parallel rows over a large area and can, at the pressures involved, deliver the equivalent of a sizable amount of gas.

The subject of peak gas demand should not be left behind without some discussion of auxiliary gas

Figure 15 — Flow diagram shows one method for storing, vaporizing and mixing propane for industrial use.

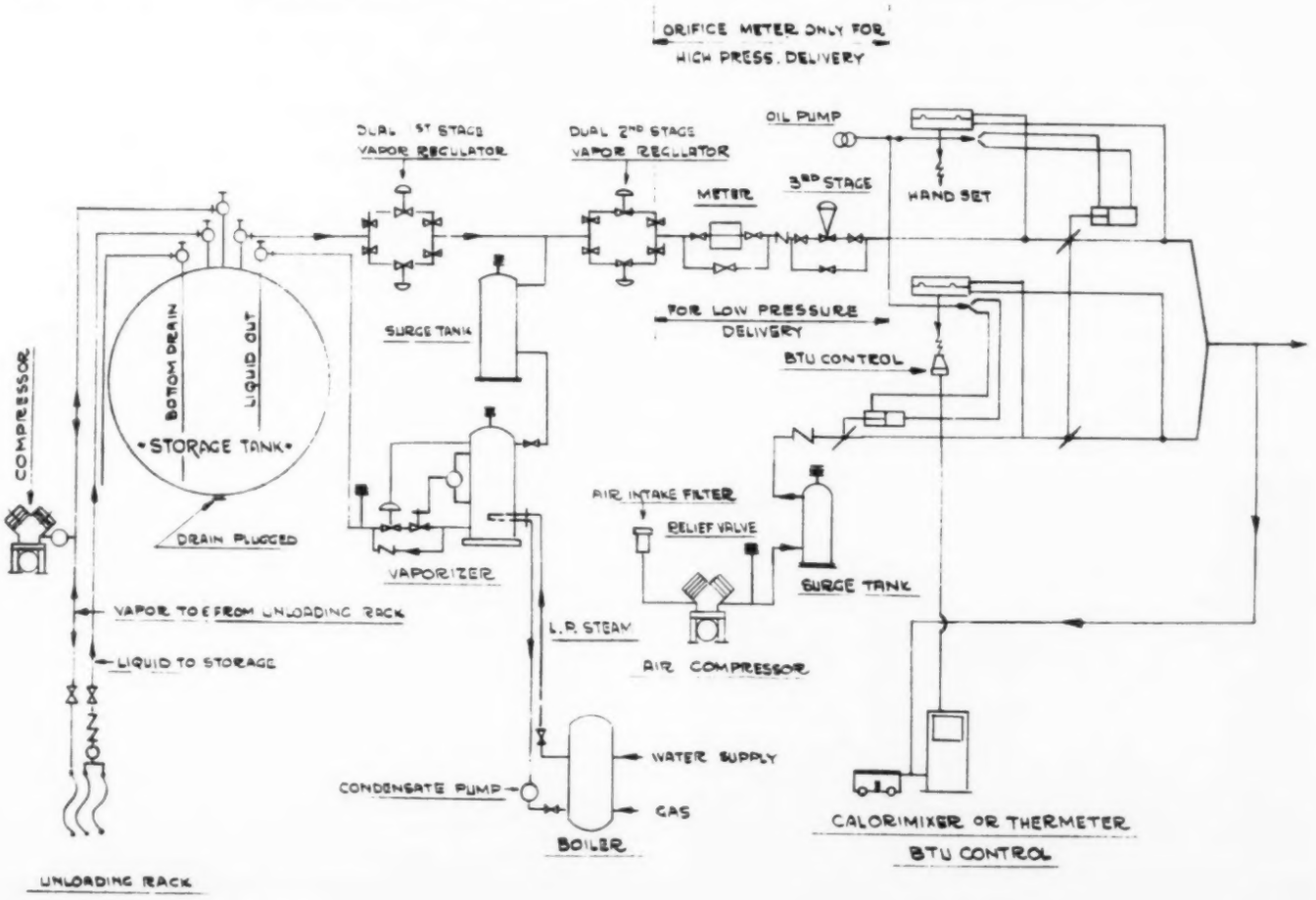


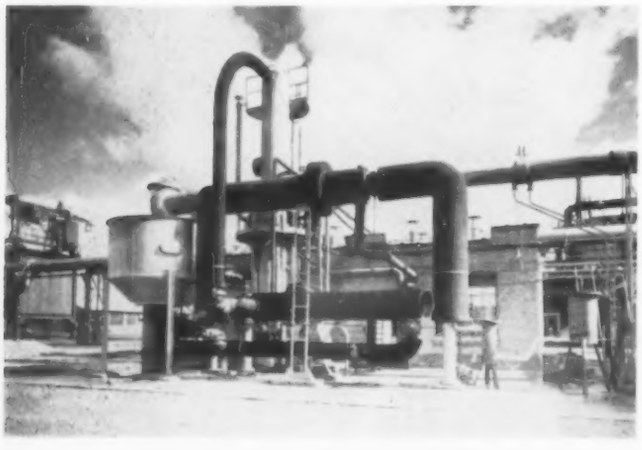
Figure 16 — Refrigerating and propane handling equipment for low temperature installation.

generation as a source of supply either on a standby basis or continuously.

A fixed gas can be produced from oil feedstock. The process oil can be a heavier oil such as Bunker C, but the equipment for processing becomes somewhat complicated and expensive. Nevertheless, a satisfactory gas is produced. Premium feedstocks permit continuous operation without by-products or purification. New catalytic methods are available, being the ultimate in cleanliness and automatic control. Such methods can deliver a substitute natural gas, a substitute coke oven gas, or a form of producer gas.

An example of a modern gas generating plant is shown in Figure 17. Premium feedstocks are needed for this particular apparatus which is a catalytic autothermic reformer (CAR). The basic gas made has a heating value of about 173 Btu per cu ft, is similar to producer gas and can be substituted for producer gas. Thus, for heat applications where producer gas is the preferred fuel, a substitute producer gas can readily be made from natural gas or from coke oven gas as the feedstock. For other applications, the CAR gas can be enriched or blended with other gases. The catalytic autothermic reformer generates gas continuously and automatically with an absolute minimum of attention. With the nature of the process and the employment of heat exchangers, the over-all thermal efficiency is in the order of 95 per cent. In various sizes, the capacity may be 50,000 to 300,000 cfhr for a single unit.

Figure 17 — An example of a modern gas generating plant.



No one particularly wants a peak demand or a variable demand problem, but such problems do exist. Utilities have them and so do many industries, notably the steel industry with hourly and daily variations and with its own special week-end stiuation.

Load equations must be worked out—adequately and economically. From a consideration of the several gas storage means described in this paper, it should be possible to make a selection to suit the type and the scope of the application. Or some means of gas generation might be required—either separately or as an adjunct to gas storage. To one or the other, or both—there is a solution!

Discussion

PRESENTED BY

G. H. KRAPF, Division Superintendent, Power Production-South Works, U. S. Steel Corp., Chicago, Ill.

R. W. KYLE, Vice President, Gas Machinery Co. Cleveland, Ohio

M. H. MAWHINNEY, Combustion Engineer, Crucible Steel Co. of America, Midland, Pa.

G. H. Krapf: I have a question of general interest. Since many of us operate plants in which large percentages of our fuel is obtained from by-product gas, which supply, may not always be in step with demand, have you helped any of the mill develop cost savings in regard to installation of holders?

In other words, what are the financial parameters that they should consider?

R. W. Kyle: That is a rather tough question. We are not holder builders, although we do occasionally make studies involving holders, or the cost of holders, other than the curves and the general information prepared here. There is no quick and easy solution to tell you that you should or should not have a holder, or how big it should be. It certainly can utilize gas which would otherwise be wasted. If that is not the situation, it probably would be hard to justify a holder.

In the first place, there are two reasons for having a holder in a steel plant. One is that it is a bubble on the line. A small holder will serve that purpose. It will take up little variations in the flow.

The other factor is the storage or accumulation of gas over a long time when the gas is not being fully utilized, so as to have it available when a heavier load does occur. Now, that is an economic study involving how big a holder you would need, how much that particular holder would cost compared to how much money we are going to throw away, and have to replace the fuel with oil or some other fuel if you do not build the holder.

The other choice is whether it is going to be low pressure or high pressure distribution, and you can pick the type of holder to go with the actual physical characteristics of the plant.

M. H. Mawhinney: The author mentioned a holder costing $395,000. Was it 1,000,000 or 2,000,000 cu ft?

R. W. Kyle: That is a 1,000,000-cu ft holder. ▲

the application of silicon and Germanium Power Rectifiers in the steel industry

by R. J. Moran,
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. . . . germanium and silicon power rectifiers have many advantages over earlier types of rectifiers and rotating equipment . . . . they will be useful in power conversion equipment for mill drives and processing lines . . . . germanium is better under 35 volts, silicon is better above this level . . . .

DEVELOPMENTS in semiconductor rectifiers during the past two years have brought about considerable change in the practice of obtaining d-c power from an a-c source. Rotating equipment and the older established types of rectifiers are being replaced by germanium and silicon rectifiers in many applications.

The field of application for these new rectifiers is not fully established as yet, and there are some differences between germanium and silicon and some limitations in both which must be considered in their application. This paper will establish some bench marks and mention some fields which look like the right places to use germanium and silicon. This paper will be concerned with power rather than control applications, and with rectifier characteristics rather than the principles of cell design.

CHARACTERISTICS

Table I gives most of the essential data for typical germanium and silicon cells available today. For the purpose of discussion throughout the paper, a cell rating of 100 amp will be assumed, recognizing that different manufacturers make different sizes of cells and also that the actual current rating depends on transformer circuitry and cooling methods.

It is obvious from Table 1 and Figure 1 that germanium has an efficiency advantage for low voltage applications since for the same current it has a lower cell drop and consequently a lower loss. It loses this advantage at higher d-c voltages since two or more germanium cells are required in series, with two or more cell losses, whereas silicon can operate to higher voltages with only one cell in series. Also, since the silicon cell is actually capable of 100 amp x 82.5 volts, or 8.25 kw versus the 3.75 kw rating of the germanium cell, it is to be expected that the silicon equipment would be more expensive for the same amperes than germanium at low voltages, since in the case of silicon, you would not be using the cells up to their full kw

TABLE I

Germanium and Silicon Cell Characteristics

Cell type	Operating peak inverse voltage	D-C output voltage		Average amp	Cell loss at rated amp, average watts	Cell efficiency at rated voltage	Maximum junction temperature, C
		*	**				
Germanium	92	37.5	75	100	78	97.9	75
Silicon	200	82.5	165	100	94	98.8	200

* In six-phase single way circuit (Figure 2A).
** In six-phase double way circuit (Figure 2B).

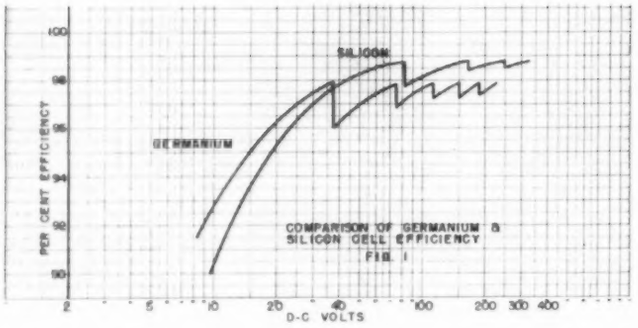


Figure 1 — Comparison of germanium and silicon cell efficiency at different voltages shows germanium better under 38 volts.

capabilities. Further improvements in semiconductor technology may narrow the economic and efficiency gap which now exists between germanium and silicon, but today the advantage is with germanium, and this means that for cleaning, pickling, plating, etc., germanium equipments will provide the best efficiency and should be more economical for these low voltage applications. We have therefore established one ground rule. Use germanium for low voltage applications, say about 35 volts and below. Use silicon for the higher voltages.

Now that we have established that germanium can take the low road and silicon the high road, what will be displaced and where can we look for new applications?

First, copper oxide and selenium are on the way out in the low voltage power field. Germanium and silicon are more efficient than copper oxide and selenium and, perhaps even more important, they are not subject to aging. Aging is a gradual increase in forward resistance and reverse leakage current resulting in higher regulation and lower efficiency. The effect is accelerated by overload and high temperature, and the end of rectifier life is generally reached when the forward resistance has doubled. Since there is no evidence of aging in germanium and silicon, they should have indefinitely long life.

Second, selenium will be displaced from the majority of the higher voltage applications. There will still be some applications for selenium where its ability to ride through high voltage transients, such as might occur in synchronous motor field circuits, will make it more suitable than silicon.

Third, the position of the low voltage motor-generator set in the cleaning, pickling and plating field is becoming slightly precarious. The usual rectifier advantages of higher efficiency, lower first cost, lower installed cost, static equipment, lower space requirements, lower maintenance cost, etc., all make rectifiers more attractive than motor-generator sets for this service.

Fourth, silicon rectifiers are beginning to move in on mercury arc rectifiers for 250-volt general purpose shop power supplies. They are more efficient than the mercury arc rectifiers, less expensive, simpler to maintain, and generally take up less floor space.

Fifth, adjustable voltage power supplies using magnetic amplifiers and silicon rectifiers will find increasing use in the processing line area. Here again the advantages of static, high defficiency equipment

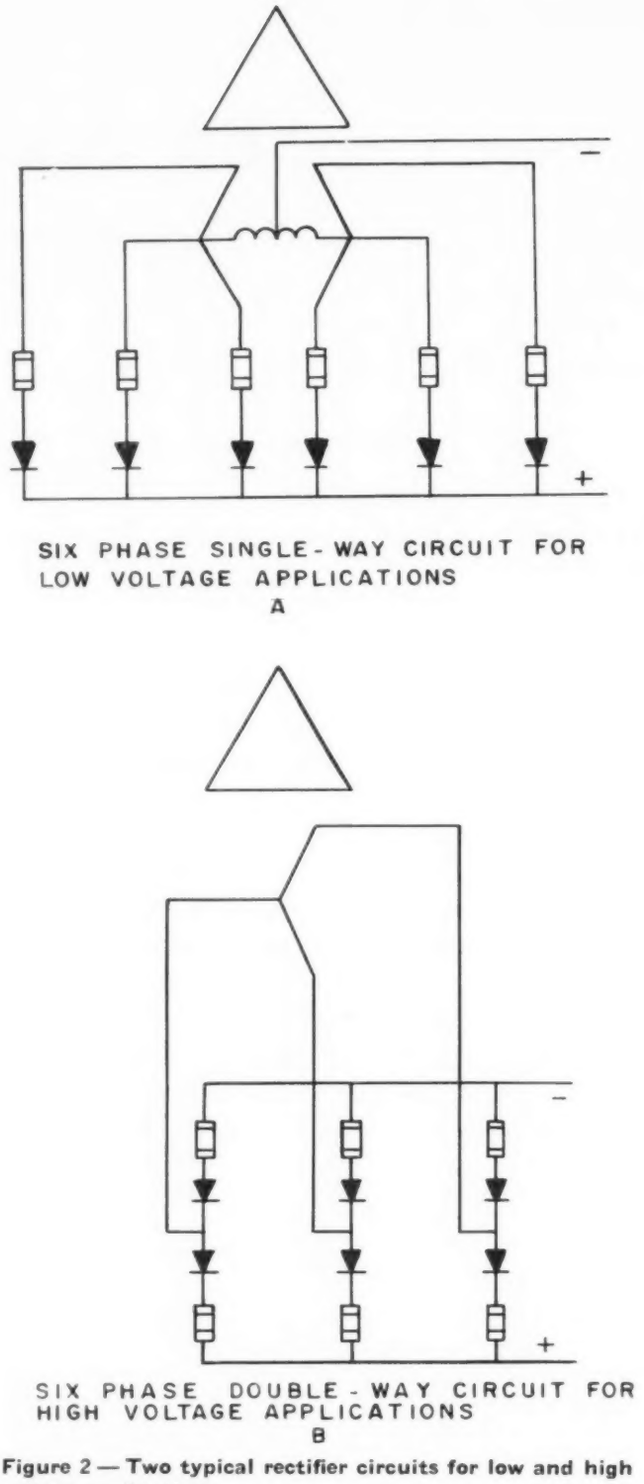


Figure 2 — Two typical rectifier circuits for low and high voltage applications.

make the adjustable voltage silicon rectifier equipment a real competitor in this field.

APPLICATIONS

Now let us take a closer look at the applications mentioned above, discuss the application requirements and see how the rectifier equipments are designed to meet them.

Low voltage power supplies—The voltages here may range from 8 to 12 volts for plating up to 24 volts for cleaning and pickling. Current ratings for individual

units range from 4000 to 10,000 amp, with as much as 200,000 amp required for some processing lines. Adjustable voltage is needed so that current can be varied as a function of line speed, strip width, and coating thickness. Rectifier units may be switched off and on many times a day as current requirements change. Short circuits can occur in the process so protection must be provided. Some cleaning and pickling operations require a reversal of the d-c voltage from time to time to prevent hydrogen ion build-up on the anodes. Reliability is important since the process requires continuous power for good strip preparation and even coating.

The voltage requirements can be met with a single germanium cell in each leg, but several cells must be used in parallel to meet the current ratings. One of the rectifier circuits which can be used is shown in Figure 2A. If the equipment were rated 6000-amp continuously, each leg would carry an average current of one-sixth of that or 1000 amp. There would be ten 100-amp cells in parallel per leg or a total of 60 cells to meet the continuous rating. Since short circuits can occur in the process, the cells must be capable of carrying the fault currents during the time it takes for protective devices to operate or for the short to clear itself. Also, in many cases the equipment will have two-hour ratings and short-time ratings and the manufacturers must consider all of these factors in addition to the continuous rating when selecting the number of cells in parallel.

The operation of rectifier cells in parallel has its problems, since the manufacturing process is such that it is not possible to make cells which are always exactly the same in characteristic. They may differ in their voltage drop at rated current and this would cause them to divide current unequally. There are three things which can be done to remedy this condition. First, the cells can be derated so that the poorest cell would not be overloaded due to the unequal current division. A second method is to test and grade the cells and use in parallel paths of any one leg only those cells which are closely matched in cell drop. A third method is to use separate devices such as balancing reactors to force the cells of different characteristics to divide current.

The latter two methods are the most widely used and are equally effective in balancing currents. Cell grading is considered the more natural method by some manufacturers since the cells are tested and graded anyway as a part of the quality control operation in the manufacturing cycle. Cells of the same grade will parallel at rated load and also during overloads and short circuits. The system is simple, requires no additional equipment, and is easily understood by maintenance personnel. The disadvantage of cell grading is that a replacement cell must be of the same grade as the cells with which it will be paralleled. However, the number of cell grades for a given installation can be controlled so that the stocking of different grades of cells can be kept to a minimum. Silicon has an advantage in this respect since the number of different grades is considerably less for silicon than for germanium cells.

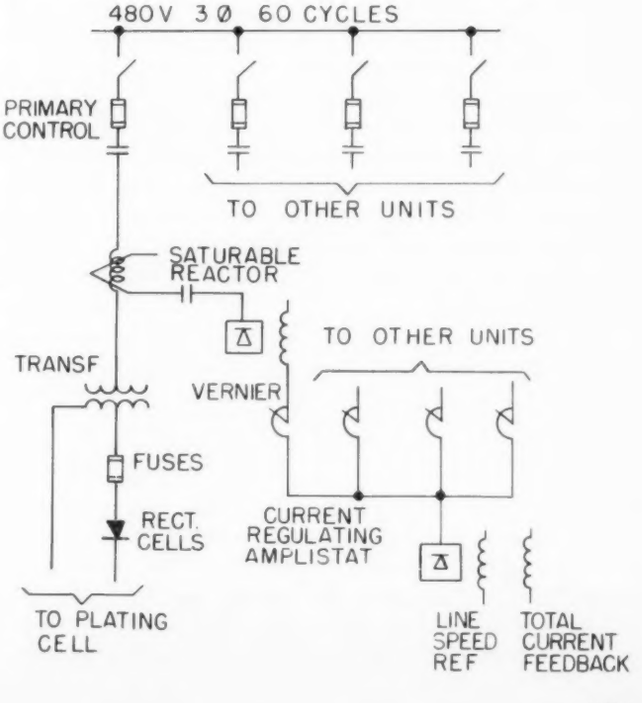
The advantage of using balancing reactors is that, within reason, cells having different voltage drops can be operated in parallel and it is therefore unnecessary to carry replacement stocks of different cell grades. The disadvantages of this method are primarily mechanical ones associated with the mounting and connecting of the added equipment. The reactors also introduce a circuit drop resulting in a minor increase in regulation.

Adjustable d-c voltage is obtained by using saturable core reactors which change the value of a-c voltage applied to the rectifier transformer, thus changing the d-c output voltage. These reactors, if properly designed, function as current limiting devices and provide the primary protection for the cells when d-c faults occur. Cell protective fuses are included to protect against internal failures.

The units are normally supplied from the low voltage a-c power system, and standard combination motor starters are used for a-c protection and switching. High current d-c reversing switches are used for polarity reversing and transfer switching where required.

The saturable core reactors and the transformers are specially designed for this service and are dipped in protective coatings for use in corrosive atmospheres. Fuse monitoring and annunciator systems are used to detect and inform the operator of cell failures. The importance of reliability and the need for continuous operation generally mean that spare cell capacity is provided so that the process will not be shut down when a cell fails. The user is in the best position to determine how he would like to operate and how much spare capacity should be provided. The minimum would be an extra cell in parallel in each leg, and the fuse monitoring system would then be arranged to sound an alarm after the first cell failure and then shut down if a second failure occurred in the same group of paralleled cells. Other factors to consider are the total current required at the time the cell failure occurs, the possibility of reducing strip speed, and other

Figure 3 — Schematic for supply and control of plating current.



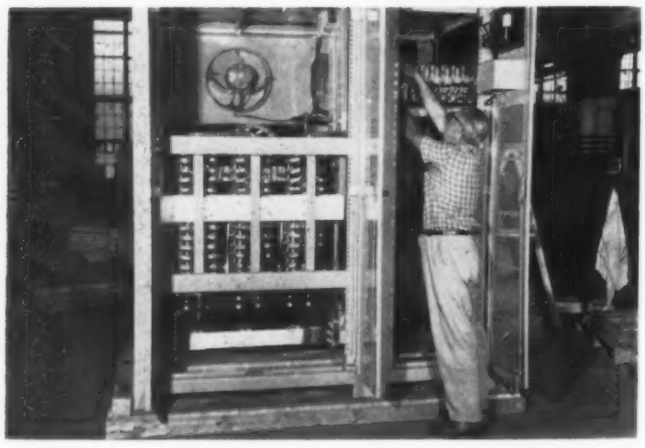


Figure 4 — Water-cooled plating rectifier is rated 7500 amp at 20 volts.

temporary measures which might be taken.

Figure 3 shows a typical one-line and schematic diagram for control of tinning line plating power. Total plating current is regulated proportional to strip speed. Adjustments are provided for strip width and coating thickness. A speed reference signal is obtained from a tachometer driven by the main bridle. The outputs of d-c current transformers in each rectifier circuit are totalized and provide the feedback signal. Magnetic amplifier regulators are used thus providing completely static power and control equipment. If differential plating is required, the rectifiers are split into "Top" and "Bottom" plating sections, each having its own current regulator. Figure 4 is typical equipment of this type, arranged for water cooling. Air cooled equipments are also available, see Figure 5. The selection of cooling method is dependent on customer preference, ambient conditions, cooling water quality, physical location in the plant, etc.

Water-cooled equipment will be more efficient than the air-cooled design when "once-through" cooling water is used because there are no circulating pump or fan losses which are chargeable to efficiency. On the other hand the air-cooled equipment will have motor-operated blowers and the losses of these blowers must be included in calculating efficiency. The expense of cooling water should be added to the operating costs to make a good over-all comparison, and if a heat exchanger or refrigerating equipment is used for the water supply, then their losses should be included in the efficiency calculations. Figure 6 shows typical efficiencies for low voltage rectifier and rotating equipment.

250-volt general purpose shop power supply—The typical 250-volt plant d-c distribution system supplies a variety of loads including mill auxiliary drives, cranes, miscellaneous motor drives, etc. The d-c system is subject to short circuits, and there are many loads capable of regenerating power into the system. A reliable power supply is required since the shutdown of mill auxiliary drives or cranes can result in considerable loss of production.

This is an application for silicon and the voltage requirements can be met using the familiar three-phase bridge or double-way circuit with two cells in

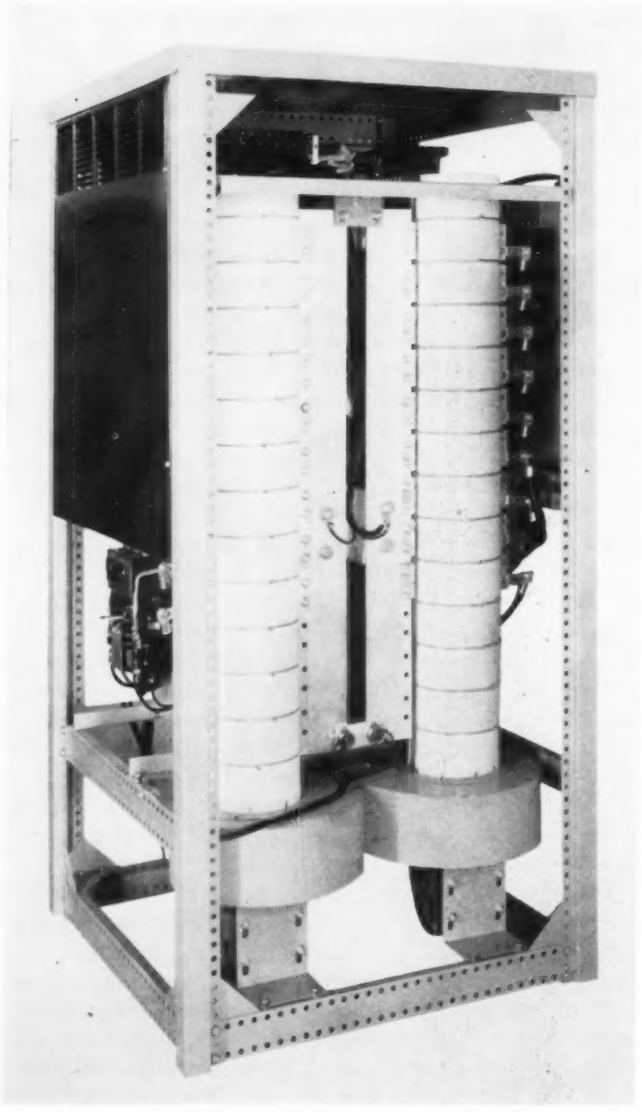


Figure 5 — Air-cooled plating rectifier is rated 3000 amp at 9 volts.

series per leg and the required number of cells in parallel. A typical rectifier circuit is shown in Figure 7. If the equipment were rated 1500 amp continuously, each leg would carry an average current of one-third of that, or 500 amp. Equipment for this service has a two hour rating of 125 per cent of rated load and a 1-min rating of 200 per cent. The number of cells in parallel is determined primarily by the short circuit conditions rather than the load conditions, since d-c faults can occur quite often and a bolted short circuit at the rectifier terminals can result in fault currents of 15 or more times rated current. The cells are selected to carry this fault current during the time it takes the d-c breaker to operate and clear the fault. Individual cell fuses are also provided and their function is to protect good cells when another cell fails. After a cell failure, the equipment would still be capable of carrying the rated load and the 2-hr load without difficulty although the 1-min rating would be decreased to some extent. Therefore, it is not necessary to shut down the equipment when a cell fails. An alarm would be sounded and when it is convenient to make a cell change, the equipment could be shut down, cells changed, and the equipment returned to service.

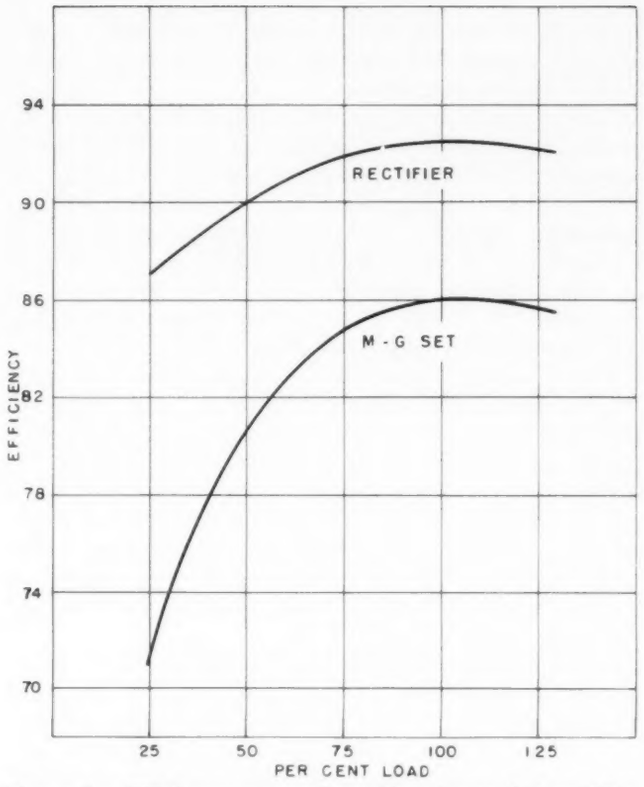
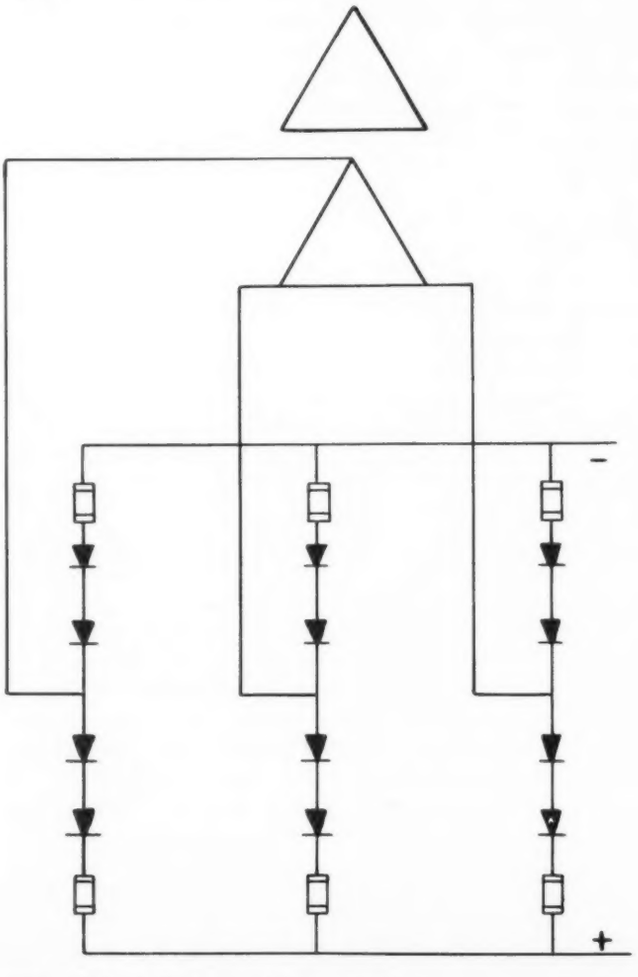


Figure 6 — Efficiency comparison of water-cooled rectifier equipment and motor-generator set at 24 volts direct current shows superiority of rectifier.

Figure 7 — Rectifier circuit for 250-volt, d-c silicon rectifier.



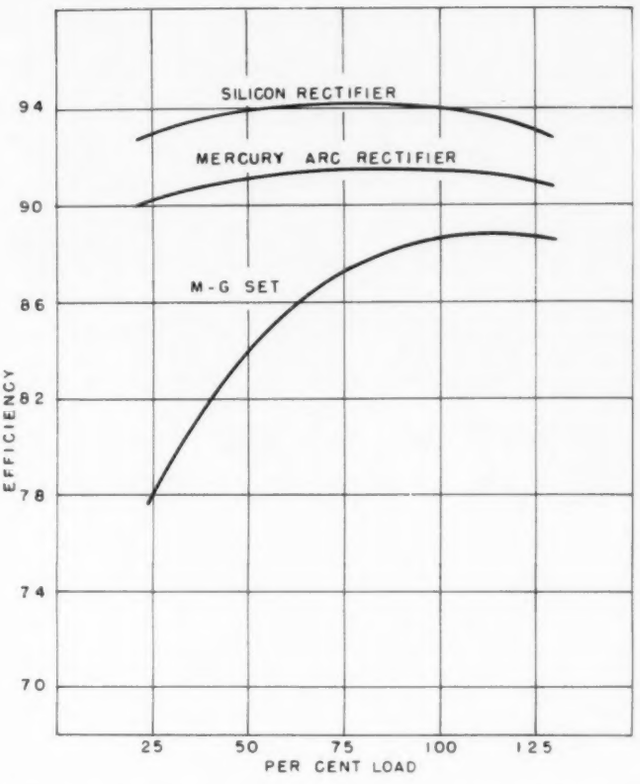


Figure 8 — Efficiency of 250-volt, d-c power supplies.

A standard line of silicon rectifier equipment has been developed, ranging from 75 to 300 kw, arranged for operation from low voltage a-c power systems. Larger equipment, through 1500 kw, is also available and can be arranged for operation from power systems in the medium voltage class. Unregulated, the voltage of this equipment varies about 7 per cent from no load to rated load, and in addition the voltage would vary directly with swings on the a-c system. This variation may not be acceptable for some applications. If required, regulated direct current can be provided by using an induction voltage regulator ahead of the rectifier transformer. The equipment is arranged for air cooling and is furnished as factory assembled packages in the case of the smaller units, or in unit substation lineups in the case of the larger equipment.

Figure 8 shows a typical efficiency curve for silicon rectifier equipment compared to mercury-arc rectifiers and motor-generator sets. Power factor is approximately 95 per cent at rated load and this value is maintained down to 25 per cent load. When supplied from medium voltage a-c systems, 2.4 to 13.8 kv, these equipments can be treated just like a-c load center unit substations. That is, a power circuit breaker is not required in the transformer primary. A disconnect switch or interrupter switch can be used in accordance with a-c load center practice and the main feeder cable, protected by a circuit breaker, can loop into the rectifier transformer and out to other loads.

As is the case with mercury-arc rectifiers, silicon rectifier equipment cannot accept reverse power so that some means must be provided to absorb regenerated power. A so-called dynamic braking panel is provided which consists of a bank of resistors, a contactor, a voltage relay and a timing relay. When

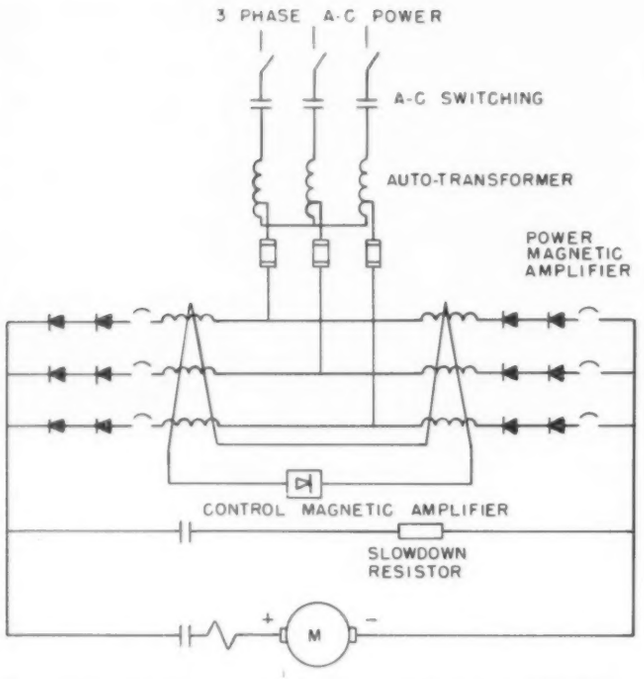


Figure 9 — Static power supply scheme for adjustable voltage motor drive.

regeneration occurs without other load on the line to absorb it, the d-c bus voltage rises and this picks up the voltage relay which closes the contactor connecting the resistor across the bus. The drive which is regenerating then pumps power into the resistor until it has slowed down to the point where its voltage is the same as the rectifier output voltage. The timing relay keeps the resistor connected to the bus for a specified time and then opens the contactor. If the overvoltage condition still exists, the contactor is again picked up and the resistor re-connected to the bus.

Static power supplies for motor drives—The requirements for adjustable voltage drive power supplies are just about as many as the number of different drive applications. In order to limit the scope of this article somewhat, this discussion well be confined to adjustable voltage drives for processing lines such as cleaning lines, coil preparation lines, etc.

Process line requirements are acceleration and deceleration, operation at various voltage levels depending upon the line speed requirements, reliability, fault protection, and ease of maintenance when trouble occurs.

The static adjustable voltage power supply uses a magnetic amplifier of the three-phase full wave type with silicon rectifier cells as shown in Figure 9. In addition the equipment includes an a-c switching device, an autotransformer to provide the correct voltage after rectification for the d-c motor, current-limiting fuses for fault protection, and a ventilating system. The normal operating voltage would be 250-volt, direct current but the maximum voltage may be 125 per cent of that, or more, when required for the overspeeding of entry and delivery ends of processing lines for refilling or emptying storage loops. The maximum operating voltage will determine the number of cells in series and the total motor horsepower supplied will determine the number of cells in parallel. Magnetic amplifier regulators are provided for control of the power supply and, except for regeneration, the same regulating functions can be provided as for generators.

The power supply, its control, and the associated motor control are all assembled in a NEMA type 1 enclosure. Since the "package" arrives at the user's plant completely assembled and tested, there will be considerable savings in installation time and cost.

Since the rectifier power supply cannot accept reverse power, a controlled slowdown equipment is provided to absorb regeneration during operating transients and for normal stopping.

The major advantages of this type of power supply can be summed up as high efficiency, fast response, lack of noise and vibration, ease of installation and maintenance, and low floor space. They have been applied for low speed processing lines in sizes up to 100 kw. The major limitation is the inability to accept reverse power so that applications requiring rapid deceleration with controlled strip tension must be studied carefully before static power supplies are selected.

Other applications—Silicon rectifier equipment is available for supplying d-c power to vacuum arc melting furnaces. In the past this type of furnace has been supplied by welder type motor-generator sets and some selenium rectifier welding equipment. The standard silicon rectifier equipments for this application are rated 3000 amp, and provide the drooping voltage characteristic necessary for arc furnace supply of approximately 80 volts no loaddown to 40 volts at rated current. Any number of the 3000-amp units can be paralleled to provide the total current required by the furnace. The complete furnace system includes, in addition to the furnace and rectifier power supply, a-c load center unit substations, a-c protective and switching devices for the rectifiers, and furnace electrode positioning drive and controls.

Hydrogen-oxygen cell lines in the steel industry are a good application for silicon rectifiers. The d-c voltage is in the order of 65 volts and this voltage is within the capabilities of a single silicon cell. The total ampere requirements can be supplied either by operating small units in parallel or by supplying one large rectifier transformer which would provide the proper a-c voltage for all of the rectifiers. This decision is primarily a matter of economics, with the larger transformer and single transformation generally resulting in a lower first cost and a higher efficiency.

SUMMARY

Germanium and silicon power rectifiers are well suited for steel mill service and when the equipment is properly selected and designed for the application, they will provide dependable, efficient power supplies. Germanium has an advantage in economy and efficiency over silicon for the low voltage applications. Silicon, because of its higher voltage capabilities, is best suited and most efficient for the medium and high voltage applications. Both types of rectifiers have many advantages over rotating equipment and the earlier types of rectifiers, and are valuable additions to the power conversion equipment available for steel industry drives and processes. ▲

Since coming into operation in January 1958, the new 46-in. high-lift bloomer at Stelco has been slowly geared up to a production rate of over 300 ingot tons per hour.

operating and mechanical features of new 46 x 110-in., high-lift Blooming Mill at Stelco

by A. C. Gray, Blooming Mill Superintendent
and J. G. Mitchell, Electrical Superintendent
Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada

THE Steel Company of Canada, Limited, Hamilton Works' plant, which is now rated at 2,400,000 ingot tons, is destined to more than double annual ingot production over the next 20 years, keeping pace with Canada's population growth and expanding economy. With the open hearths operating at this 2,400,000-ton figure, they consistently out-produced blooming mill capacity. No. 1 bloom mill, which has a 44-34-in. tandem mill combination, in line with an 18-in. billet mill, performed creditably during the years of company growth to the present time. The big tonnage year, 1956, saw 2,139,000 ingot tons processed to slabs, blooms and billets in this mill, but it was recognized that the limit of its productive capacity had been reached. The future of No. 1 mill will be primarily geared to bloom and billet production for the rod and bar mills, with a small proportion of slabs for flat rolled product to maintain operating flexibility.

The decision to install No. 2 bloom mill for production of slabs was made in 1955. Figure 1 shows the location of the new unit and the layout of the Hamilton Works plant. The mill is immediately adjacent to future extensions of the flat rolled division toward the north of the plant.

The initial building is 1000 ft long with the pit building 450 ft and the mill 550 ft in length. See Figure 2. The pit building is 120 ft wide with a lean-to for operating control houses and work shops 23 x 375 ft running along the east side. The mill building is 100 ft wide with an 80/20-ton crane and the motor room 94 ft 4⅛ in. wide x 250 ft long, is on its eastern side, serviced by a 60-ton crane. In line with the motor room at the southeast corner of the mill building is a cooling yard 94 ft 4⅛ in. x 175 ft long also serviced by a 60-ton crane. The scale pit and crop handling bay is 50 ft wide x 275 ft long and lies on the west side of the mill aisle with a double drum crane rated at 10 tons for a magnet, and 7½ tons for a scale bucket. The track layout shown in Figures 1 and 2 indicate the flexibility we have in servicing No. 2 bloom mill by rail.

Foundation—Approximately 75,000 cu yd of material had to be excavated for the substructure of the building and equipment.

Mill soaking pits and basements were founded on piles. In order to drive piles, additional excavation to remove heavy layers of fused slag fill was necessary. This was done by blasting which was carried down to about 45 ft below finished grade. Some 2,100 steel monotube piles filled with concrete were used, being 12 ft in diam and averaging 80 ft in length. Design load per pile was 75 tons.

The control depth both in design and construction was the scale pit and the mill flume. The flume was set 27 ft below mill floor level and 500 ft in length.

Approximately 36,000 cu yd of reinforced concrete were used to complete the foundation. All concrete tested at over 3,000 psi with an admixture. Reinforcing steel amounted up to 120 lb per cu yd of concrete in many parts of the foundation.

Soaking pits—The soaking pit layout has incoming hot steel tracks and the ingot buggy tracks on the same side of the pits. This permits better accessibility to the pits for operators and allows mechanized delivery of repair materials such as recuperator tile, brick, seal castings, etc. Initially we built one steel track and one ingot buggy track on the west side of the pits, and there is room to add a second steel track and a second ingot buggy track in the future. In the meantime, we are using this space for ingot storage (Figure 3).

In designing the pit building, full use was made of the vertical space between the control deck and the pit basement. We have an I-beam supported concrete floor at ground level, capable of taking a load of 1000 lb per sq ft. This makes desirable storage for palletized re-

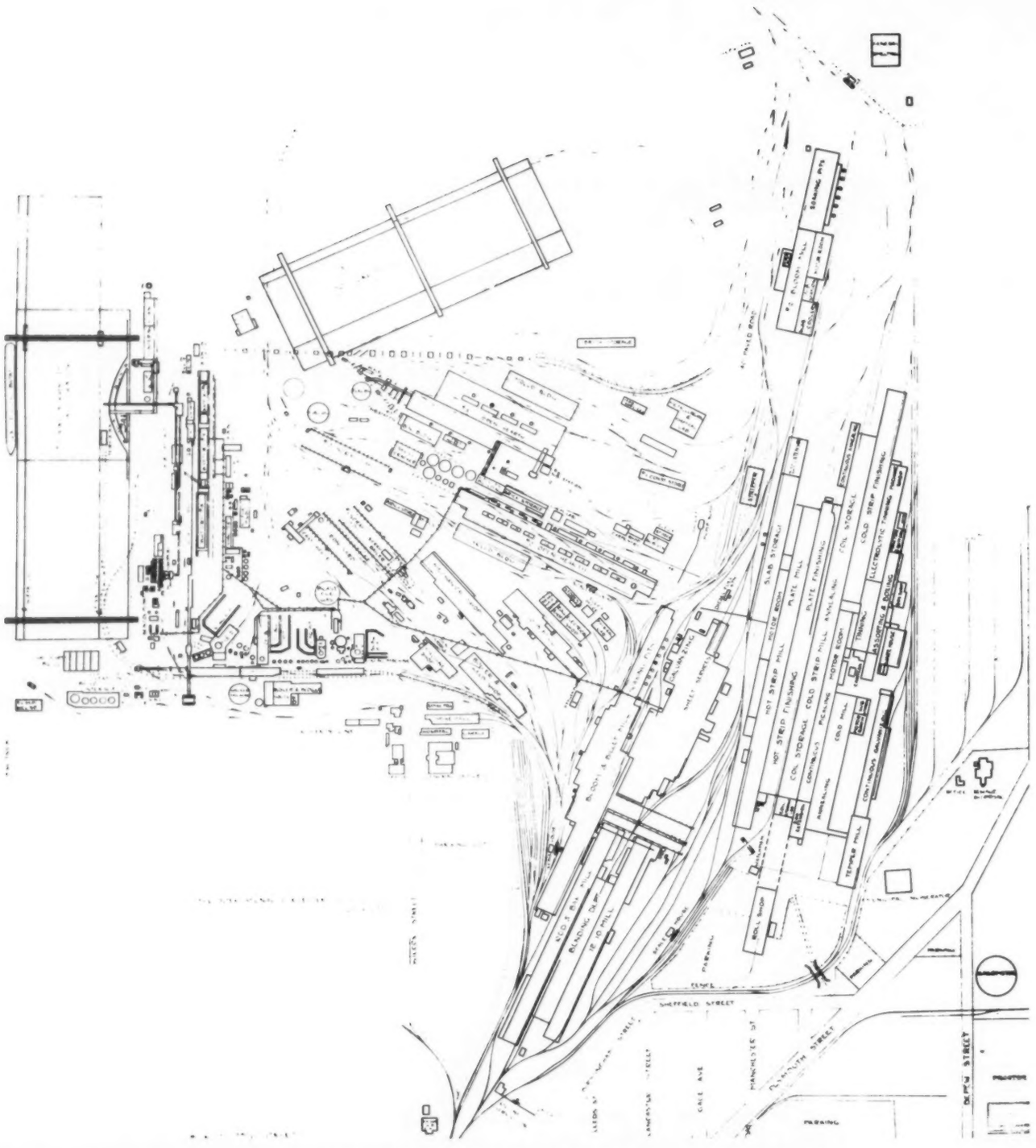


Figure 1 — General arrangement of Hamilton Works plant of The Steel Company of Canada, Ltd.

fractories used in pit maintenance. There is ample headroom at control, ground and basement levels for flexible use of forked lift trucks. Front end loaders are employed in the basement for quick removal of pit bottom cinder. There is provision for a future service elevator between the three levels. At the north end of the pit banks there is a pit cover repair stand at ground elevation. Three separate truck entrances at north, central and south locations permit ready servicing of pit maintenance requirements. Natural air circulation under the pits is proving adequate for good working conditions at the three levels. Seasonal changes in our part of Southern Ontario bring an annual temperature range which may run from 90 to −10 F. To meet this, the pit building has a wide, open monitor running the full length of the peak, plus sliding sheet panels in major parts of the siding. Where used, every third sheet is fixed and the sheets on either side can be moved in line with the fixture to permit a two-thirds opening during hot weather and a sufficiently tight siding to give protection in winter at a low cost and a considerable annual saving in siding maintenance.

Initially, we have 12 pits, 2 holes per bank (Figure 4). The pits are 18 ft square x 11 ft 6 in deep, bottom fired with one burner per pit, and allowing for corbels, wall camber, firing port area, etc., we have approxi-

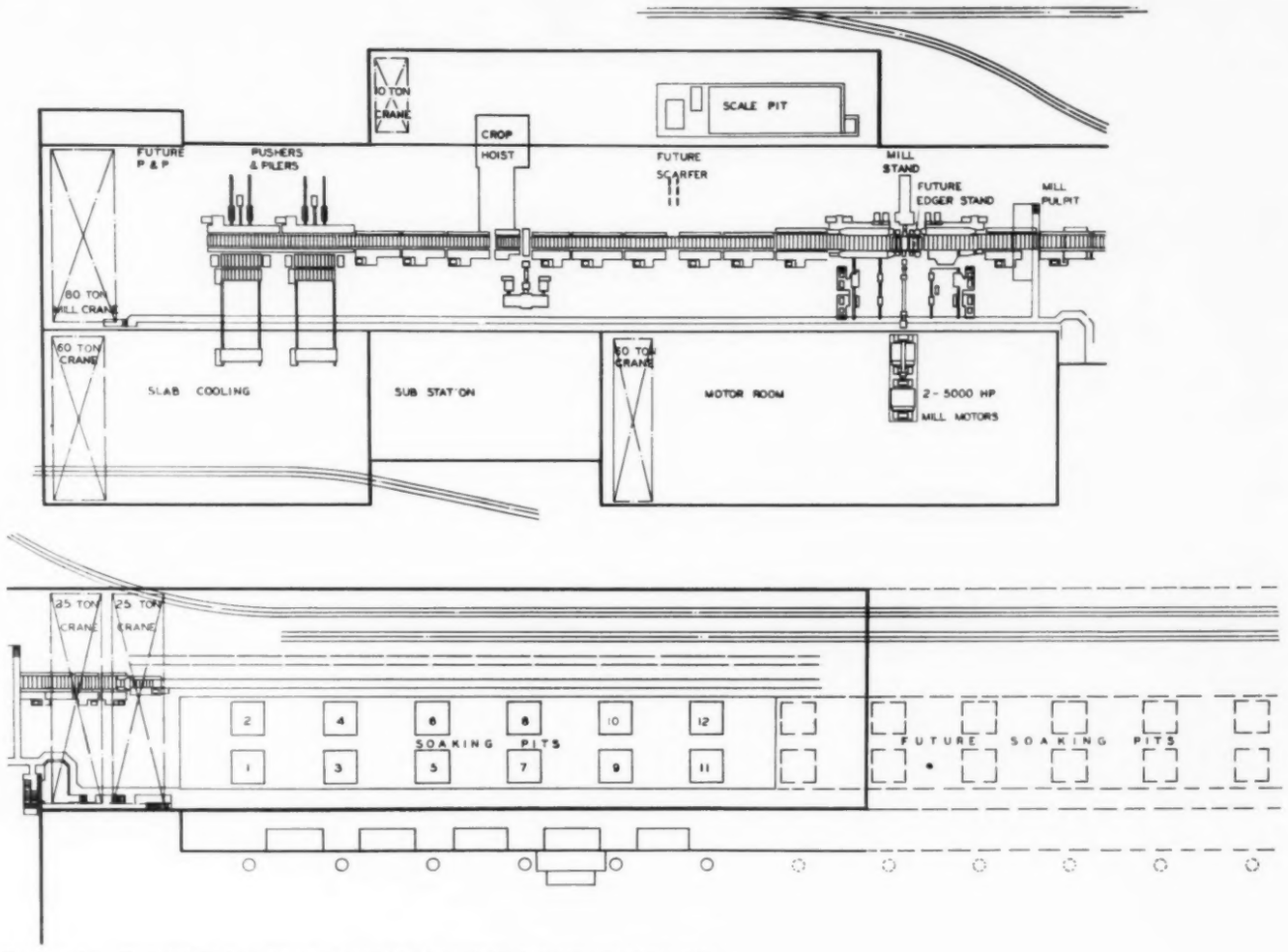


Figure 2 — Provision has been made for possible future soaking pits.

mately 3200 sq ft of usable hearth area. Slag bottom practice is employed in this new pit installation, as in those at No. 1 bloom mill. The pits are 26 ft 6 in. center to center on their width and 50 ft center to center on their length. Capacity is 150 ingot tons per pit. There are two refractory recuperators per pit using silicon carbide tile. We develop 1600 F of preheat in air for combustion. The flue pipes are lined with castable refractory. Stacks are 5 ft 3 in. inside diam, 135 ft high, brick lined. The normal fuel mix is six parts of blast furnace to one part of coke oven gas, with blast furnace at 90 Btu per cu ft and coke oven at 550 Btu per cu ft. Provision is made to change individual pit gas mixtures over the full range from straight blast to straight coke oven gas. The burners consist of heat resisting chrome-nickel pipes, a 5 in. inside diam pipe for coke gas built inside a 13-in. inside diam pipe for blast furnace gas leading to alloy burner tips where mixing takes place. Combustion air meets the gases at this point inside the burner port.

Heat input is rated at 24,000,000 Btu per hour when using 150-Btu mix. Combustion air is supplied by one fan per pit rated at 6400 cfm at 6 in. water column.

Figure 3 — Incoming hot steel and ingot buggy tracks are on the same side of the pits.

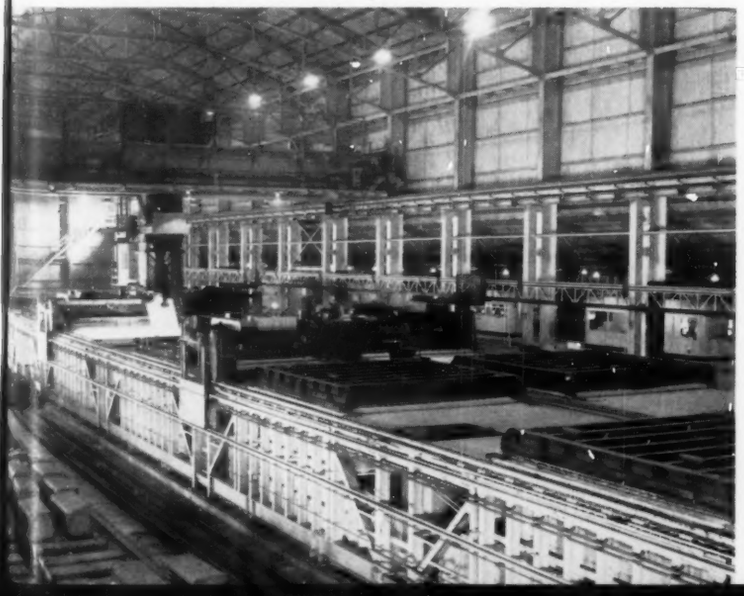
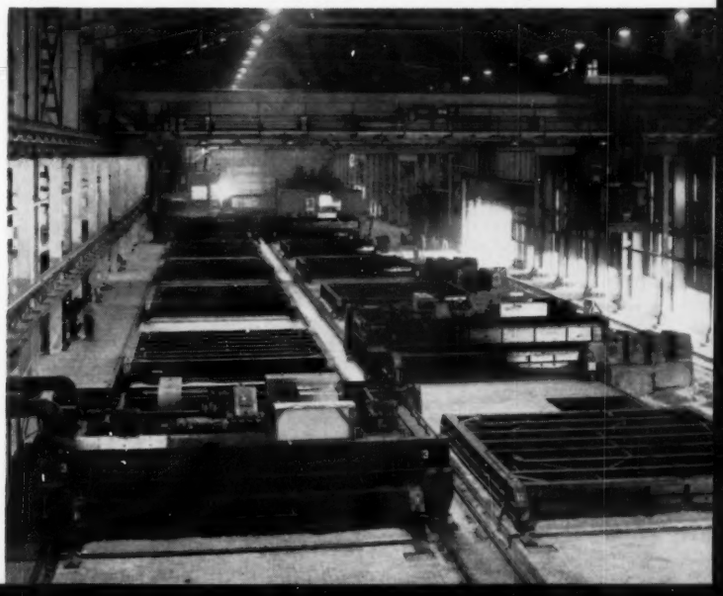


Figure 4 — Pits are 18 ft square x 11 ft-6 in. deep.



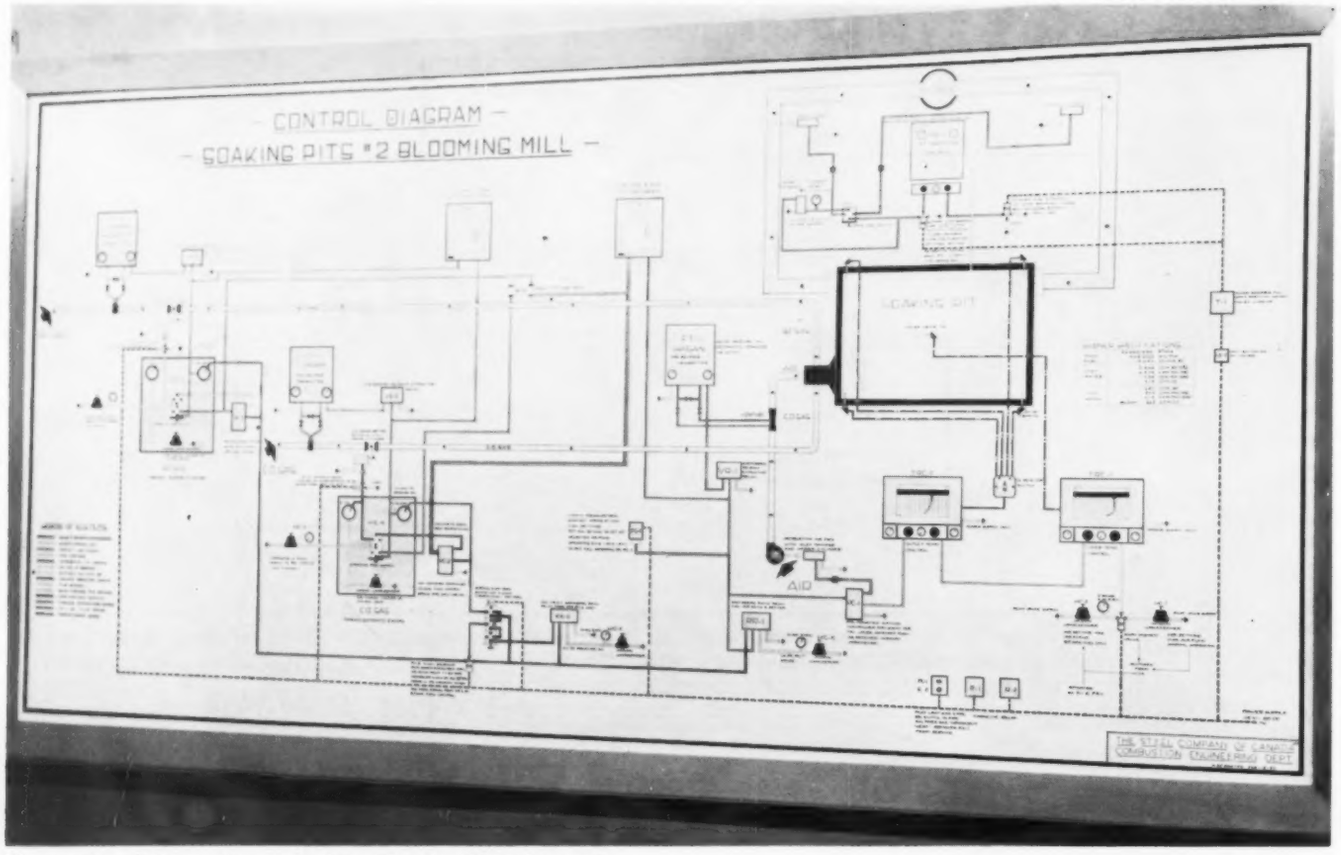


Figure 5 — Schematic control for No. 2 mill soaking pits.

The most advanced type of controls have been installed enabling us to choose a predetermined Btu value for individual pits during any part of the cycle. Thereby, we can start on straight coke oven gas, change to mixed gas part way through the cycle, and finish on blast furnace gas during the soaking period when this is to our advantage. There is temperature control on each cover as well as four outlet temperature controls in the pit using platinum, platinum-rhodium thermocouples. There are controls on coke oven and blast furnace gas valves, combustion air fan vanes and waste gas dampers. Figure 5 shows the control circuits and details of their effectiveness will be published at a later date.

Pit covers weigh 36 tons each, and are designed to minimize sagging. They use suspended tile refractory. Sand seal castings are a spheroidal iron and heat resisting 25–12 alloy steel. There are four cover carriages, two each for inside and outside rows. Normally each cover services three pits but can travel the full length of the present pit installation when necessary at a speed of 130 fpm. They have a 6-in. lift and are radio controlled from the two soaking pit cranes or a centrally located station on the pit control deck. They may also be manually operated.

The soaking pits are served by 2 pit cranes, rated at 25-ton capacity. A ring fitted in a slotted lug on the tongs is used for making auxiliary lifts. The crane span is 113 ft $5\frac{3}{8}$ in. which probably makes these the largest span soaking pit cranes in existence. These cranes are designed to take an intensified grip on the ingot to minimize the hazard of ingots slipping from the tongs. See Figure 6. A spare tongs assembly is mounted in a deep pit at the mill end of the building where either crane can operate, to minimize crane downtime for tong replacement. Crane cabs are air-conditioned and afford maximum vision for the crane operators who are responsible for sending the loaded ingot buggy to the mill receiving table. Ingots are sent butt first to the mill by crane manipulation of each ingot when it is placed on the buggy. There is, therefore, no need for a turnabout in the mill line (Figure 7).

Ingot buggy—The roller-top ingot buggy has five deeply grooved forged steel rollers, 18 in. diam x 48 in. long, spaced 28 in. which are lineshaft driven. These

Figure 6 — Two pit cranes serve soaking pits.

rollers are equipped with tapered roller bearings on the drive side, straight roller bearings on the opposite side and are driven by a reduction gear drive unit when collector shoes engage a live mast at the mill table end of the run. There are stationary cast steel sideguards on each side of the roller table. The entire unit is mounted on a heavy welded steel car frame with four single flanged wheels. Total weight is 110 tons. Track gage is 4 ft 8½ in.; wheel diameter is 36 in. When delivering an ingot, braking is accomplished by the use of a cam rotate on which brake shoes are mounted which engage tracks built inside the runway tracks. The rotate functions when dragend cable tension fails, or any time the buggy passes a series of checkpoints within 70 ft of the mill table at excessive speed, through a solenoid arrangement. A tapered-side hopper with counterweighted doors under the rollers collects scale in transit, which is dumped to the mill flume system as track cams operate the doors by levers at the mill receiving table. The buggy is cable operated with 1½-in. cables attached to fore and aft keels on the car. The cable runs in a steel-channel protected trough to cable drum drives, 200-hp, located at each end of the pit building in concrete dugouts. The drives are 53 ft 6 in. outside the building columns, giving a distance of 105 ft 6 in. from sheaves mounted on center line of buggy runway at mill end, to permit proper lead of cables to the drums. The cable drums are motor driven through totally enclosed gear drives and gear type flexible couplings. Traverse speed of the ingot buggy is 1000 fpm.

46-in. mill—The ingot buggy rollers are energized immediately the mill tables are reached, delivering the ingot without delay to the ingot receiving table. A photocell sights on the ingot when on the receiving table and permits the empty buggy to return to one of the pit stations. The first two sections of the mill table system are identical, so the section following the receiving table will become the receiving table for the second ingot buggy runway at a later date. The space now taken up by this second table will be utilized for a transfer section to move ingots from the second line to the mill line. The third table section on the approach side of the mill is longer and was designed to be used as an ingot scale table if desired at a later date. These three table sections are constant potential units, operating automatically or manually, with a photocell stopping hot ingots at the ingot scale table when approaching the mill until it is advanced by the roller-manipulator team. These units are all lineshaft driven, with forged steel table rollers, 18-in. diam, 84 in. long, spaced 29 in., having the same bearings as noted for the ingot buggy. All lineshafts are equipped with backup sleeves between bevel gears.

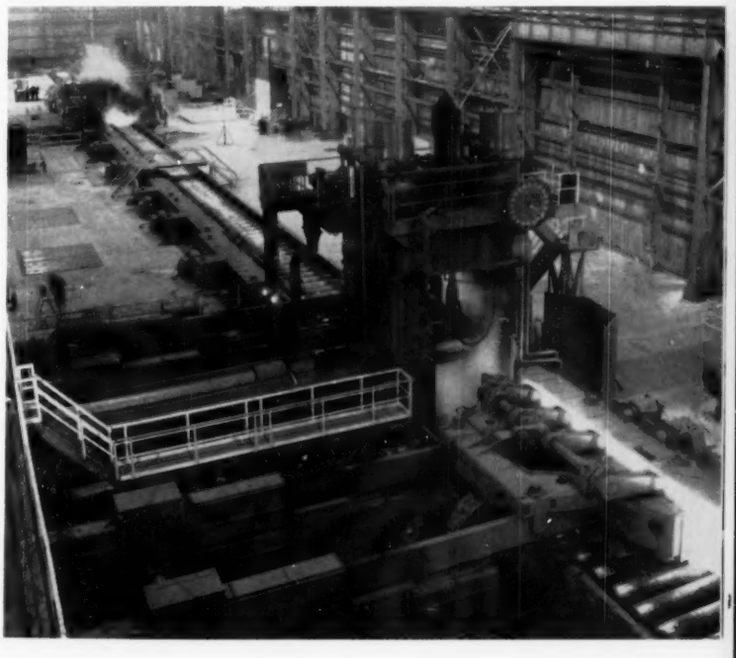
Table girders are cast steel, box section on drive side and beam section at opposite side. The bottom half of the lineshaft trough and dead eyes are cast integral. Stationary rolled steel sideguards on both sides of the table are attached to cast steel apron type supports and have 80 in. clear between them. Tables are driven through enclosed roller bearing equipped reduction gear drives, with the gear case cast integral with the table girders. Gear type flexible motor couplings are used. Table speeds are 331 fpm for sections Nos. 1 and 2, and the ingot scale table.

Figure 7 — Ingots are sent butt first to the mill.

The secondary front and back mill tables are built on the same principle with 12 rollers, 18-in. diam, 100 in. long. These, with the primary tables and feed rolls have variable voltage control. Speed is 840 fpm. Table rollers throughout are forged steel.

The primary front and back tables are duplicates except opposite hand. They contain 14 rollers 20-in. diam x 111 in. long, spaced on 29 in. and are slightly over 31 ft long. All rollers are mounted on roller bearings in cast steel table beams and girders. See Figure 8. The first four table rollers each side of the mill are arranged in pairs with one twin helical gear drive, 75 hp for each set of rollers. The remaining ten rollers are lineshaft driven, with cast steel gear and forged pinions, roller bearing mounted, in totally enclosed drive case cast integral with the lineshaft trough. The entire primary tables are mounted on 7-in. machined steel impact plates.

Figure 8 — Front and back tables are duplicates except opposite hand.



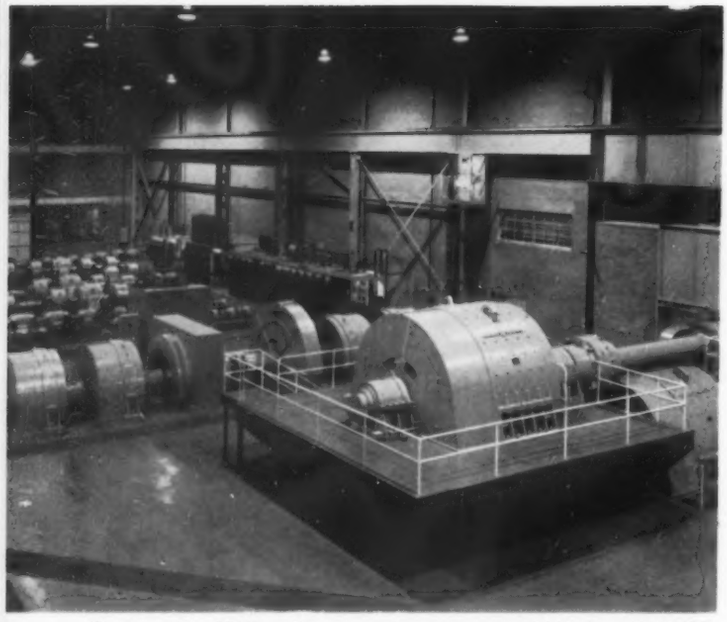


Figure 9 — Mill rolls are driven by two 5000-hp, 0/40/80-rpm motors.

The manipulators are of welded construction, movable sideguard type, on both entry and delivery side of the mill. They are pin mounted on forged steel rams, which slide on bronze lined supports. These supports are self alining by a pivot mount on a welded steel base. Rams are motor-driven through a totally enclosed gear stand with a lineshaft connecting all four ram drives. Maximum ram speed is 180 fpm and maximum opening between sideguards is 100 in. There are four lifting fingers on the drive side of the entry manipulator, with provision for the same equipment on the delivery side of the mill at a later date. These fingers are forged steel and operate in guides in the sideguard. They are pin mounted to a tilting lever which in turn is keyed to a pivot shaft. This shaft is connected by links and levers to a traveling bar which has one wheel riding on a tilt platen. The platen is raised and lowered by crank, bell crank and links. The finger speed is 25 lifts per minute, and lift is four ft.

Mill—The mill as initially installed is a 2-high stand, with rolls 46-in. diam x 100-in. body length. It is equipped with total enclosed composition type bearings in cast steel chocks held in position by cast steel clamps. Housing windows and bearing chocks are equipped with steel liners. The roll balance is hydraulic and the maximum roll opening is 78 in. The mill screws are forged alloy steel, 18-in. diam, $2\frac{1}{4}$ in. pitch and run in manganese bronze screw boxes at a top speed of 555 in. per minute. Roll couplings are designed to slide on spade ends of work rolls with set pin locking to prevent end movement of the coupling.

The mill rolls are driven individually, by 5000-hp motors 0/40/80-fpm speed rating (Figure 9), with a reversal time of 1.5 sec at base speed, through 35-ft forged alloy steel spindles. The spindles are universal coupled at each end, using bronze slippers, and are direct-connected to drive motors by a crab coupling. The bottom spindle is supported by two spring balanced babbitted carriers, and also has a hydraulic jack for adjustment in roll changes. The top spindle is supported by two carriers mounted in forged steel carrier bars attached through links at the mill end of the hydraulic system.

There are three individually driven feed rolls on the entry side of the mill and two on the delivery side. The two outside feed rolls on the entry side will be removed in the future when a 36-in. edging mill is installed. Provisions for this edger unit were made in foundation construction.

While average ingot weight at present is 11.5 tons, this mill is designed to roll ingots weighing 30 tons, 78 x 32 x 110-in. size, to slab sizes up to 72 in. wide and 28 ft long in the future. At present the rolls have three passes, 14, $6\frac{1}{2}$ and $4\frac{5}{8}$ in, with a $63\frac{1}{2}$-in. bullhead. See Figure 10. Horizontal bar ragging is used in the 14-in. pass, and notched "ocean wave" ragging on the bullhead.

Figure 10 — Mill is designed to roll ingots weighing up to 30 tons.

The mill has a motor-operated roll changing rig consisting of a cast steel carriage under the bottom roll chocks, arranged to slide on liners on a cast steel girder between the housings and on a welded steel track outside the housing.

The mill pulpit is located over the secondary entry table 60 ft from the mill. Cooling air is obtained from the motor room. The roller's chair is located on a platform directly above the center line of the mill tables, with the manipulator's chair to the roller's right, slightly forward, mounted from pulpit floor elevation. This second chair is pointed at a slight angle off center toward the drive side housing, giving the roller a wide range view of the manipulator's movements. Visibility forward, laterally and rear is good for both operators (Figure 11).

Each operator can control the movement of ingots from the receiving table to the mill secondary table. The roller has control of the primary tables and can take control of the secondary tables which are normally the manipulator's responsibility, if necessary. Duplicate push button panels controlling all these tables are mounted to the right of each chair (Figure 12), having a master cancel button for use any time it is necessary

Figure 11 — Operator has good visibility.

to change the setup and progress an ingot manually. This has eliminated the familiar widespread battery of standard controllers. Foot treadles located in front of each operator control the direction of table rollers. The roller has a push button control to return the

Figure 12 — Manipulator operator is shown on left, and roller is on right.

Figure 13 — Desired mill opening shows up as an illuminated figure on a narrow panel.

ingot buggy to the various stations at the soaking pits.

The mill screwdown is controlled by a preset. The preset is initiated by a hand-operated wheel mounted on its vertical axis on the left side of the roller's chair. The desired mill opening shows as an illuminated figure on a narrow panel mounted at the front of the pulpit to the roller's left. See Figure 13. The roller operates the screwdown drive by a push button mounted in the main motor drive lever located on his right, the actual opening between bullheads matching the preset figure on the panel. This panel replaced the usual selsyn dial indicator in the pulpit.

On the delivery side of the mill are several table sections viz. mill runout, scarfer approach, scarfer trailing, where a scarfing unit may be located in the future at a point 127 ft from the mill, scarfer delivery followed by shear approach and shear entry sections. These table sections are built in the same principle as described for the mill approach tables and run at a speed of 402 fpm. At present these are constant potential units with provision to install variable voltage control when necessary.

Shear—The down and up cut shear is located 207 ft from the mill, is motor driven and each knife head is hydraulically balanced with the weight type hydraulic accumulator, 1000 psi. See Figure 14. In operation the top knife head lowers to a point just off the slab, and as the crank continues to rotate, the bottom knife

Figure 14 — The down-and-up cut shear is located 207 ft from the mill.

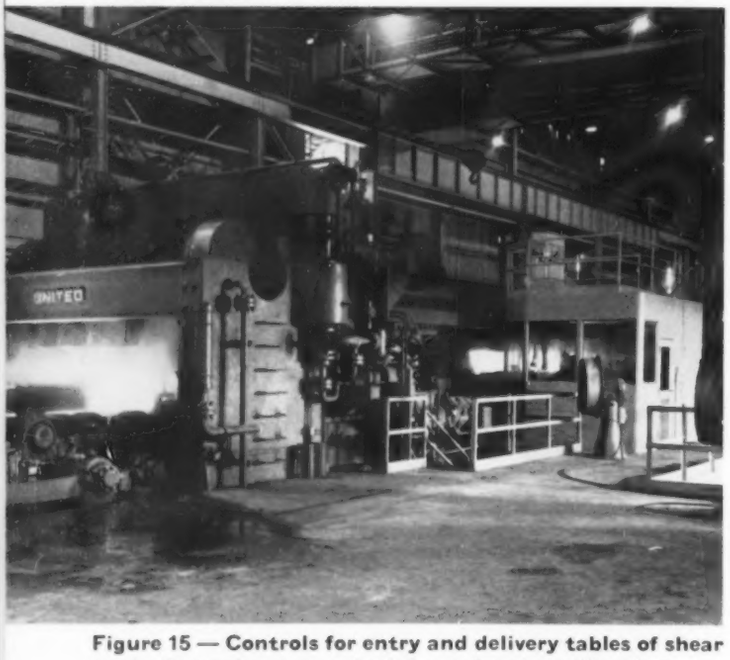
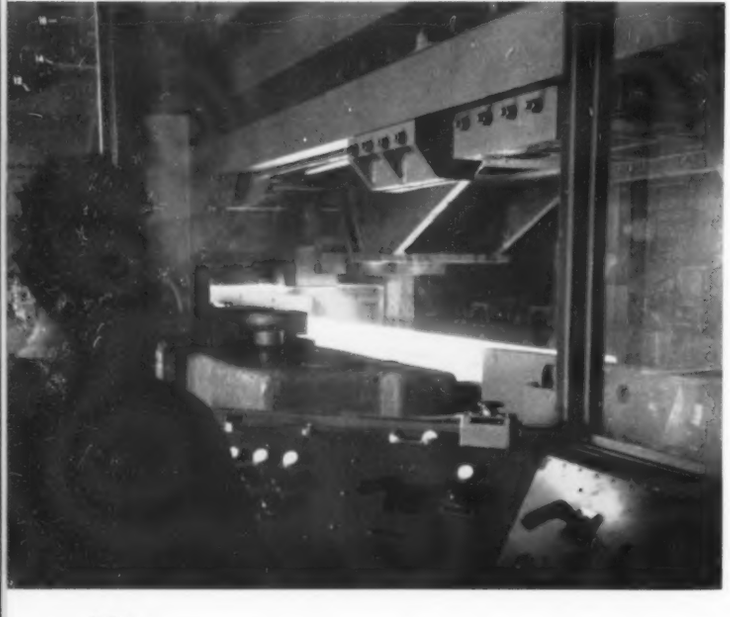


Figure 15 — Controls for entry and delivery tables of shear are built on the same principles as for the mill pulpit.

Figure 16 — Shear operator has a good view of the cutting operation.



rises, engaging the slab and making the cut with the slab lifted to clear the table. There is a hydraulically-operated gag on the delivery side of the top shear knife head. The shear is rated at a maximum knife pressure of 3,000,000 lb and has a capacity to shear a 12 x 50-in. slab, 8½ x 72-in. slab or a 16 x 16-in. maximum bloom. There is a 21-in. clear opening between knives, a 20-in. maximum knife opening above table rollers and the shear operates through a 22½-in. stroke at 8½ strokes per minute. Slabs may be sheared in the range from 5 to 28-ft lengths. The cast steel gage head has a renewable steel face plate equipped with bronze liners. This head is counterbalanced and is raised or lowered electrically through an enclosed worm gear reducing unit, crank, connecting rod, levers and links. The maximum lift of the gage head is 29 in. and operates at 29 lifts per minute. The gage carriage is traversed through two triple-thread forged steel screws 12 in. in diam, 1½-in. pitch, operating in bronze nuts in the drag block and enclosed worm gear reducing units, electrically driven. Traverse speed is 34.3 fpm. The shear pull-back table is a double lineshaft driven unit 12 ft long, having nine rollers 16 in. in diam spaced 18 in. The table speed is 414 fpm, the pull-back stroke is 24 in. and the traverse speed is 63½ fpm. There are adjustable sideguards on the shear entry and pull-back tables used to straighten the slab for correct shearing. The sideguards on the pull-back table require 4.5 sec to move from 18-in. minimum to 80-in. maximum opening.

The shear pulpit is located 20 ft from the shear on the delivery side, Figure 15. The controls for entry and delivery tables are built on the same principles as noted in the mill pulpit. See Figure 16.

Crops drop to a heavy welded steel top chute on the delivery side of the shear and are deflected by a hanging plate to a cast steel bottom chute arranged at 90 degrees to the top section, where they are delivered to the crop car immersed in recirculating cooling water, with an overflow connection to the scale flume. The bottom chute has a cast steel gate which is hinged at the top and operated by a hydraulic cylinder through a crank and lever. The crop car is a welded steel structure mounted on four double flanged wheels having forged steel axles. The track gage is 9 ft 9½ in. There are rope connections on both sides of the front axle for rope traverse of the car up an inclined track. The crops are dumped outside the building in a receiving pit as the car tilts over the head frame.

The shear gage table operates at a speed of 416 fpm and is followed by a scale table section operating at the same speed. Initially we have not installed a scale. Alongside the scale table is a pneumatic stamping unit suspended from a boom which may be moved clear of the roller line for quick change of stamping figures.

A transfer approach table 36 ft long operates at a speed of 416 fpm. This is followed by two slab loading tables each having slab and pile pushers and a piler to clear the line of slabs, form a slab pile and broadside the pile to transfer cars. See Figure 17. The piler-pusher operator's pulpit is located above the mill catwalk opposite the piler area. Provision has been made for the addition of controls for a third piler unit in the future.

The slab pusher head is equipped with ten forged steel top-hinged pusher fingers on 24-in. centers. The head is mounted on two welded steel rams at 10 ft centers, arranged to travel on guide rollers. They are traversed electrically through a gear reduction unit, racks and pinions. The maximum stroke is 10 ft-10½ in. and the traverse speed is 120 fpm. The pile pusher head which is equipped with wearing plates is mounted on similar rams directly beneath the slab pusher rams and traverses through a maximum stroke of 7 ft-6 in. at a speed of 58 fpm.

The slab pilers consist of the heavily ribbed cast steel platform mounted on two forged steel screws, 12 in. in diameter, 3-in. pitch, spaced 14 ft-4 in. apart. Lifting screws operate at a speed of 17 fpm through a standard right angle reduction drive and beveled gearing totally enclosed in the screw housing.

The transfer cars which are 4-wheel with 2-wheel drive move at a speed of 196 fpm on a 24 ft-3 in. track gage to the slab cooling yard, where the slab piles are picked up by a C-hook (Figure 18) suspended from the 60-ton yard crane and are deposited on slab cars for delivery to the plate and strip storage yard. The C-hooks are adjusted to take long or short slab cuts by a drag cable built in the head of the C-hook frame operated through a gear reduction unit by the crane operator.

Scalehandling has been adequately provided for the entire mill layout from the mill receiving table to the end stop beyond the slab pushers, an over-all length of 508 ft. The scale pit 25 x 75 x 42 ft deep is located in the same runway as used for crop handling. Flumes installed with a slope of ¾ in. per ft run from the ingot receiving table to a point 43 ft south of the mill, and branch west, delivering to the north end of the scale pit. The flume from the shears at a slope of ⅝ in. per ft joins the first at this point of confluence. The slope from this point to the discharge into the scale pit is ½ in. per ft.

Flume liners for a distance of 50 ft on each side of the mill are made of manganese steel, the remainder being a nickel iron. Steel grate bars 2 x 6-in. section are spaced at 8-in. centers the full length of the flume run to catch large pieces of scrap which could damage the liners. Such pieces are removed by chain falls and handled by monorail to a dry pit which is serviced by the scale pit crane.

At the south end of the main chamber of the scale pit there are underflow and overflow weirs to a second chamber 8 ft-6 in. x 25 ft which is equipped with screens and a slot overflow to the pump chamber which is 17 x 25 ft. There are six scale pit pumps used in recirculating scale flushing water. Two of these recirculate 2500 gpm to the flume at the ingot receiving table, two recirculate 1500 gpm to the end of the flume system under the slab transfer tables, and two deliver excess water to the plant sewer. The pumps are vertical shaft turbine type. Scale is bucketed from the pit to scale trucks by the 10-ton crane which is also equipped to handle crops and other scrap by magnet.

Lubrication—Automatic grease systems are used to lubricate the operating side of all table rolls, and such points as the ingot buggy, mill stand, feed rolls, spindle carriers, shear gage traverse drive, crop chute, slab pushers and pilers. One centralized circulating oil system of 175-gpm capacity, 2200-SSU is used for table drives from ingot receiving to slab transfer table inclusive. A second circulating oil system of 150-gpm capacity, 2200-SSU, serves the manipulator drive. A third circulating system 25-gpm capacity, 3000-SSU, serves the screwdown. An additional system serves the motor generator set for the main drive. These various circulating systems have stand-by constant volume pumps for full protection of mill equipment. Oil cooling is carried out in vertical columns mounted in the oil cellar.

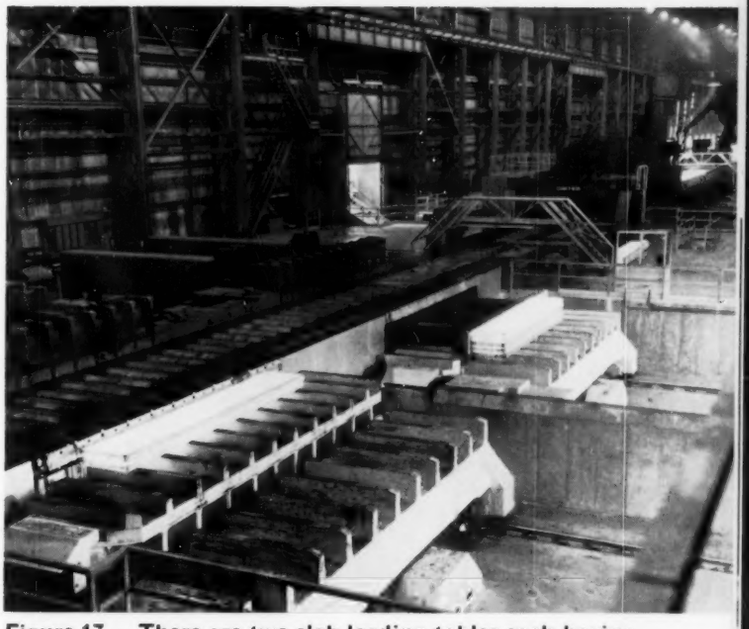
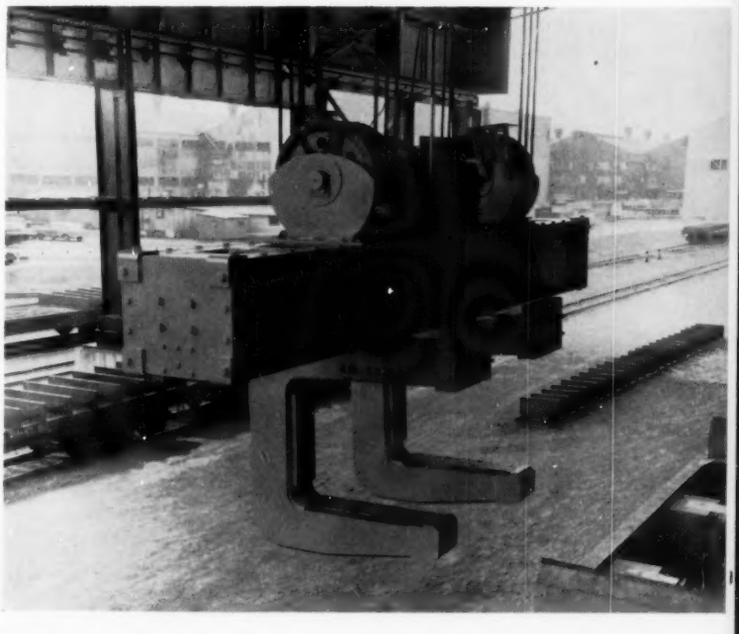


Figure 17 — There are two slab loading tables each having slab and pile pushers and a piler.

SUMMARY

Since coming into operation in January, 1958, this mill has been slowly geared up to a current production rate of 300 ingot tons per hour. Ultimate capacity will depend on larger ingots, additional soaking pits and the changeover to a universal mill. ▲

Figure 18 — C-hook is used to pick up slabs in slab cooling yard.



Railroad Car Rebuilds and Repair at Kaiser's Fontana Works

by A. B. Stoker
Foreman
Car Repair Shop
Kaiser Steel Corp.,
Fontana, Calif.

Kaiser has developed procedures in their steel plant shops which enable them to build railroad cars much less expensively and much better adapted to their needs than can be purchased.

TO railroads and most steel companies, car repair means simply the repairing of damaged cars, so that they can be returned to their original condition. When we started our department it meant the same thing to us. However, as we repaired the same cars over and over again, we began to wonder what could be done to prevent so much maintenance.

First we considered the gondola car. Our company was forced to buy some condemned gondola cars and repair them for use in our yard, in order to meet the requirements of its 1947 expansion program. These cars served the purpose and filled the immediate need, but the hard usage given them soon showed up and it was a major project to keep them in service. That problem, therefore, was instrumental in the origination of our car building program.

Experience showed that all of our cars, regardless of the companies from which we purchased them, were seriously lacking in durability. Figure 1 shows the cross section, about 12 ft back from either end in any stand-

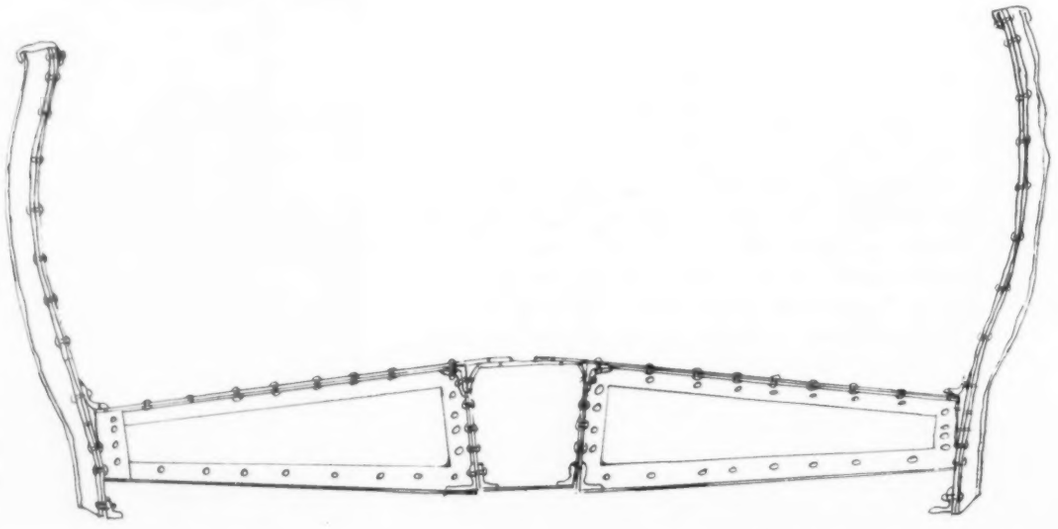


Figure 1 — Cross section of gondola car indicates bowing caused by loading and unloading with the large magnet.

ard gondola car. The center sills are from 12 to 22-in. deep and are known as drop center reinforced. They are fabricated from $\frac{3}{8}$ or $\frac{1}{2}$-in. plate with angles riveted to top and bottom. The diaphragms are usually press formed from $\frac{1}{4}$-in. plate, and these space the center sills 13 in. apart. The connections between the center sill and the sides are called needle beams. It takes more than needle beams to ward off the abuse of hot bloom butts and heavy steel scrap. The side sills consist of a heavy angle laid along the end of the needle beams and riveted to the sides and beams. Clip angles are riveted to the ends and form the connection to the sides of the car. These are $\frac{3}{8}$-in. plate reinforced with either formed pieces or "H" or "I" beams on the outside. These with top and bottom sills give rigidity to the sides.

The floor is laid from side sill to side sill and fastened with rivets to the needle beams and center sill. Because of the width of the car, the floor is made in two pieces and welded down the center with a single pass. The floors are usually $\frac{1}{4}$ or $\frac{3}{8}$-in. plate.

Study showed us that the main cause of damage to cars in service occurred during the loading and unloading of materials by magnets at the mill, open hearth, and scrap yard. A 5 to 7-ton magnet needs to travel only a foot or so to strike a terrific blow. Figure 1 shows the result of thousands of these blows. The sides get stretched out, giving the car the chance to sink in the center bringing pressure on the needle beams; they in turn act as a lever to pull the top of the center sill apart. The formed diaphragm spreads easily, letting the floor spread apart down the center. We are now carrying the load on bowed out sides and center sills. With the lowering of the center of the car, the ends rise and the car is headed for the rip track.

We made equipment to straighten these sides. Along with heat and cutting torches, we were able to bring them back somewhere near, but far from, their original strength. The same was true with the center sills. Numerous holes punched for rivets take away a great deal of strength from any one of these members when the rivets become loose and fall out. A stretched plate can never be returned to its original shape and strength.

The loading and unloading also results in a collection of nonmagnetic materials, which come off the metals being moved. The material accumulates in the bottom of the cars, and after several months amounted to as much as 15 tons of dead weight. Therefore, not only valuable floor space was being wasted, but also extreme pressures were created on the car which caused rivets to fail and materially weaken the general structure of the car.

In one typical example of damaged sides, floor and ends, there were warped sides and weld failure in the floor. This car had been in varied service that goes with the making of steel, from hot bloom butts to tin scrap. An attempt to strengthen it was made by welding a diaphragm along the side and to the floor. This was soon beat down and lost its usefulness. The failure of the weld down the middle of the car allowed the sills and sides to dish-out, and car became a flexible rather than a rigid construction.

To clean gondola cars was a slow, expensive hand operation. Actually this car partially cleaned itself, the dirt passing out the holes along the side and center of the car. We followed this idea by making a double bottom basket type floor, with openings over the entire floor, allowing fine waste material to filter out onto the roadbed.

Our first car had been in service a couple of weeks when we received word from a mill foreman that our new car had holes in the bottom and could not be used. What happened? He had dumped dirt in a gondola car instead of a dump car.

Our first attempt to build a durable car was not very successful. The sides were warped and weakened by the intense heat given off by the hot bloom butts. This coupled with thousands of collisions of magnets with the sides of the car, damaged it.

Our next car was improved by putting structural steel shapes along the inside walls and ends to help ward off the impact of the magnets and heavy steel loads. These also helped to insulate the car from the intense heat radiated from the hot steel. Then an improved car was developed with "H" beams lining the interior walls and ends. It had a basket type floor. We made two experimental cars, one with the "H" beam webs parallel to the walls, the second with the flanges parallel to the walls. The car with the webs parallel to the walls, was in service two years, and in that period it needed no repair. While the car sustained numerous small dents, the car structure remained straight and sturdy. The car that had flanges parallel to the walls had the same service and in appearance looked better than the first car, but a study showed that the flanges trapped the waste material and cut down the car capacity. So it was decided to construct future cars with the webs *parallel* to the sides. These structural shapes on the inside of the car act as a buffer to the blows from the magnet, distributing the impact over a larger area.

The following will briefly describe the method of gondola construction used:

For the center sill, we start with two 18-in. steel channels, welding the diaphragms on one, and the lug castings on both of them. Then one channel is placed on top of the other. The diaphragm is welded to the

Figure 2 — View shows construction phase of the center sills, bolsters, needle beams and girder sections in rebuilding of gondola.

Figure 3 — Inside of gondola car with protecting "I"-beams shows the self-cleaning bottom.

lower channel so that the entire operation is completed with flat welding. The center sill is then completed by turning it over and adding the center plates and center castings. We use the name lug castings and center castings because they are railroad terms. In our case they are not castings, but fabricated pieces. The center castings are cut from 2½-in. plate, the lug castings are built from short pieces of 18-in. channel. The carrier plate along with the lug castings, form a unit pocket for the coupler assembly, which consists of three pieces, coupler, yoke and gear. The gear is an assembled spring piece which is placed in the yoke centerline, attached to the coupler, by a 1½ by 5-in. cross key that passes through the slot in the side of the center sill, the slotted end of the yoke and the slot in the neck of the coupler. These are placed in position when they turn the center sill right side up. The elongated slot allows for the 2½-in. travel created by the give and take action of the coupler gear. After placing the center sill on a set of trucks, the bolster, consisting of a reinforced 8-in. "H" beam which is welded to the center sill with four ½-in. plates. Figure 2 shows all the construction discussed so far, including the bolster. This makes a sturdy section that requires very little fitting and with the "H" beams running the full width of the car ties the sides together. It also forms the side bearings which are set to meet the side bearings on the truck bolster. About four feet on each side of the middle of the center sill we place a girded section, made up of five ¾-in. plates, which completely encircles the center sill. This acts as a truss member and distributes the weight from the center to the sides of the car. Because we *do not* have to meet railroad specifications of standard distance between the floor of the car to the track, we cut our needle beams full width of the car and place them on top of the center sill. This again requires less welding and we use more needle beams then in regular construction. We place them 24-in. from center to center. The sides are made in a horizontal position; the drop center construction feature gives us an area to weld our off center girder sections too. The 18-in. channel is welded at right angles to the side, and in placing the completed side on the car, the channel rests on the bolster ends and the needle beams where it is welded. The welding to the sides of the girdered section and bolsters involves one of the few vertical welding jobs on the entire car.

After welding the additional channels which run the

Figure 4 — Drawing through the girder section shows how it supports and conducts the weight to the sides of the car. The channels give added strength and insulation when hot metal is loaded.

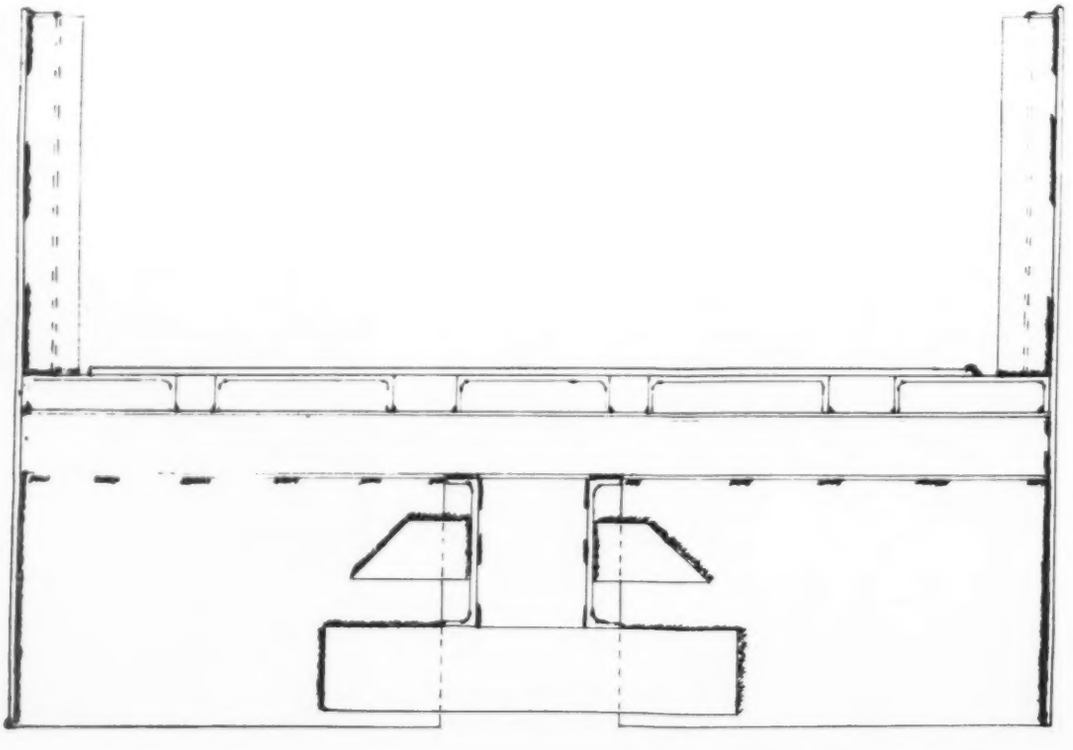


Figure 5 — Completed gondola car is pleasing in appearance.

full length of the car to the needle beams, the basket effect is created by running $\frac{3}{4}$-in. strip across the channel (Figure 3). The car is then completed by placing the ends, welding the corners and adding the regular hardware. Our cars are not indestructible; they will come back to us from time to time for repairs; but we have guarded the basic structures so that, we hope, all we will have to replace are some short "I" beams, maybe a floor plate or two or even a section of the 18-in. channel in the floor supports.

Figure 4 is a drawing of the cross section of the cars at the girder supports. The 18-in. channels used as center sill and floor supports. The $\frac{3}{4}$-in. plates on the side are tied together with more plates and secured to the center sill. There are two 8-in. channels, one on each side of these plates. They match the 8-in. "H" beams we use for needle beams. One can see the floor plates, also the structural shapes. The top sill is a $\frac{3}{4}$ x 4-in. bar stock. We use $\frac{5}{8}$-in. plates for our sides. The design is simple and needs no complicated layout, is easy to fit up, and the all-welded construction loses no strength from rivet holes. In Figure 5 is seen a completed gondola. This car has nice lines, ample space on the ends for brakeman and a protected brake gear.

The new gondola cars are 40-ft long; they weigh approximately 68,000 lb. They were first made entirely of rejected plate and structural shapes; actually we were making scrap cars from scrap. But because we are building more cars, it has become necessary to use more prime plate and some prime structural members, but most of our structural members still come to us as short pieces, primarily scrap. We use standard railroad trucks with $5\frac{1}{2}$ by 10-in. journals.

These cars require approximately 350 manhours to build.

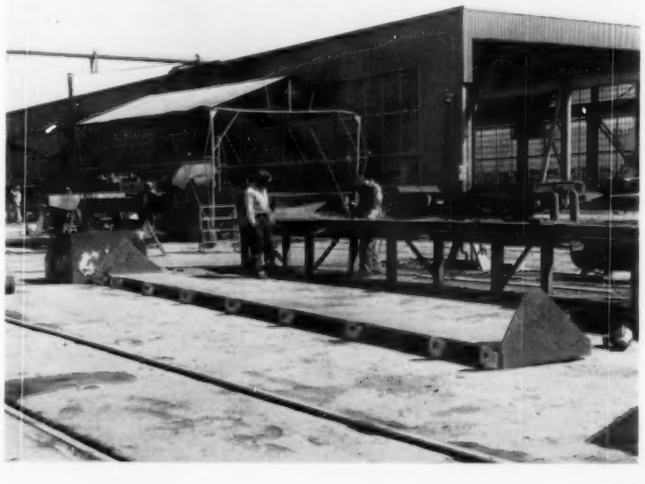
We are also constructing 40 and 65-ft *flat cars*, using the same construction as the gondola cars up to the top of the needle beams. Two heavy angles are welded to the ends of the needle beams, in order to give the side sills twice as much weld area in their connection to the needle beams. The car has the same drop center feature as the gondola. These cars are costing about $\frac{2}{3}$ of what we have to pay on the market. In building the 65-ft cars, we have reinforced the center sill with a trussed structure. A plate is anchored back of each bolster, and dropped 22 in. at the center, with supporting plates which tie it to the center sills. We turn the center sill upside down to do this, supporting it at the ends and applying pressure at the center. We give it a

Figure 6 — Dump cars were also rebuilt.

$1\frac{1}{2}$-in. camber over the full length of the car structure. This added strength, material and welding increase our construction costs considerably.

Our next problem was to rebuild a dump car so that we could furnish a car that would withstand heavy loading and tremendous abuse to which it would be exposed at the open hearth and blast furnace. The cars which we had were of too light construction. The dump doors and dumping mechanism, as well as the car bodies were damaged and worn beyond economical and feasible repair. We designed a new dumping device combining a bell crank and arms, which are activated as the air cylinders raise the car bed to the dumping position. The center sill and dump cylinders were from old cars. After the first car we changed the construction of the bed by using 8-in. "H" beams spaced about three in. apart and running the full length of the car. On the top of the "H" beams we welded $\frac{1}{2}$-in. plate in various scrap sizes as can be seen in Figure 6. Notice that the ends were built in to accommodate the bell crank assembly, and angled in at the top to withstand the inpact of the clam buckets, which are used to move the cars. By making the cars slightly higher, the same number of cu ft is still available, even though the end had been moved in and sloped. We use $\frac{3}{8}$-in. or any available plate for the floor, which is placed on top of $\frac{1}{2}$-in. plate strips and welded to the edge

Figure 7 — Doors for dump car were made more sturdy.



and plug welded down each side of center, making a solid floor.

The car doors are constructed of ½-in. plate and 18-in. channels. Notice that nine hinges were used on the doors (Figure 7). Instead of the four hinges used on the old cars. We have found that the new doors have maintained their shape much longer. Figure 8 shows a nearly completed dump car. The bell crank and arms are clearly visible. The first dump car we built was made similar to the old cars with the floor beam across the body, and most of the weight in this case is carried on the side sill. The connection of the bell crank to the center sill, and the connection from the door to the bell crank, was changed to a fabricated piece for "do it yourself" construction. A flexible connection is necessary because sometimes the car is dumped on a pile of material that limits the door short of a full open position.

We have found these new dump cars a tremendous success, with our maintenance problems considerably reduced. The dump cars require about 900 manhours to rebuild.

In conclusion, we will mention one of the small but important improvements which we made. When one of our hot metal carriers needed to have a set of trucks changed, it had always been necessary to use an open hearth ladle crane to lift one end of the car, the total

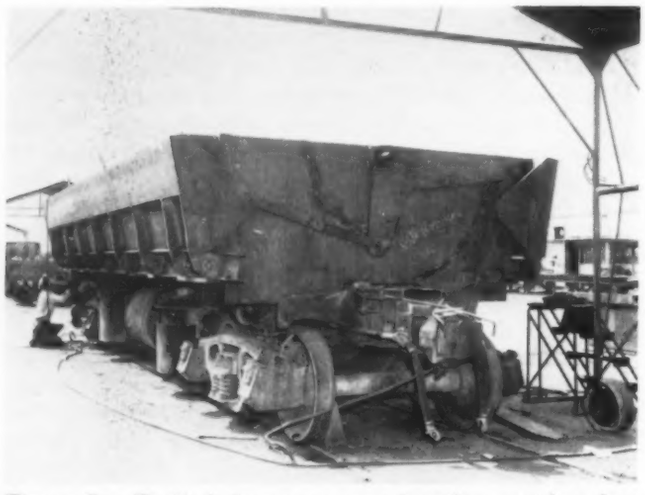


Figure 8 — Revised dump car construction requires less maintenance.

Figure 9 — Completed dump car requires about 900 manhours to rebuild.

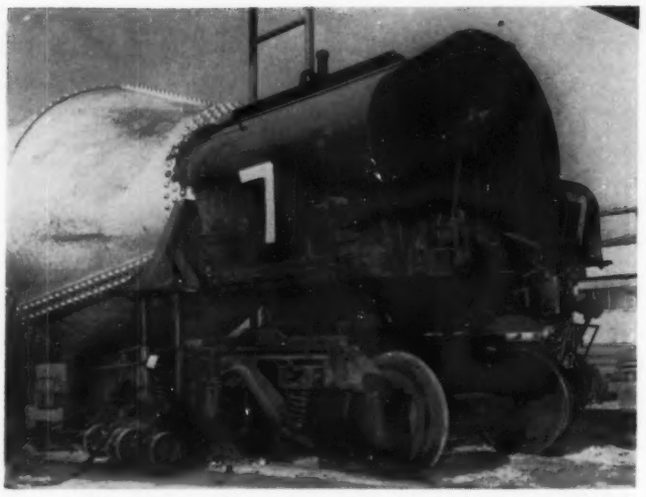


Figure 10 — An outrigger was added for lifting end of hot metal carrier.

weight of which is approximately 185 tons when empty. Obviously it involved considerable time and expense to tie up an open hearth ladle crane for a truck change, therefore, it became necessary for some other lifting device to be designed. Since there were no facilities for spotting jacks on the cars, we designed two outriggers, each of which could handle two jacks. See Figure 10. The outriggers are placed on opposite sides of one end of the car, and four 50-ton air-operated jacks lift the car off the truck safely, simply and inexpensively. The only crane service necessary is the use of a mobile crane which is needed to lift the 12½-ton truck off and to place the new truck on the track.

The changes made in operation of railroad car repair and rebuilding are the results of the combined ideas and efforts of the Kaiser Steel Corp. car repair personnel, and the encouragement and help given us by our company management. Consequently, we can build railroad cars much less expensively, and much better adapted to our needs than can be purchased.

Due to the greatly expanded operations of the plant, the need for additional railroad cars of all types will naturally be greatly increased and the car repair department will, of course, grow with this need.

Discussion

PRESENTED BY

KENNETH HUNT, Supt.
Construction Maint. & Shops,
Crucible Steel Co. of America, Midland, Pa.

A. B. STOKER, Foreman, Car Repair Shop,
Kaiser Steel Corp., Fontana, Calif.

J. L. KERINS, Assistant Vice President — Industrial Engineering, United States Steel Corp., Pittsburgh, Pa.

E. F. DONATIC, General Supt., Kaiser Steel Corp., Fontana, Calif.

D. A. BRYAN, Supt.
General Service & Transportation, Duquesne Works,
United States Steel Corp., Duquesne, Pa.

Kenneth Hunt: I am quite interested in knowing what type of welding you use on these cars.

A. B. Stoker: We use standard welding machines,

both the transformer type and the motor generated type. For ordinary and vertical welding, we use the No. 7 rod. For flat welding, we use the No. 5 rod or equivalent. We are gradually shifting over to transformer welders.

Kenneth Hunt: Are there any chances of getting any drawings of these cars and a picture of the completed car? Also, what has been the ability of the new type car you built to stand the hard use it is subject to? I understand you have one or more in use for over six months.

A. B. Stoker: Drawings and pictures are available at any time. The cars stand up very well. We have had several in use for over six months.

J. L. Kerins: From the illustration, it would appear that these cars were built to carry tonnages considerably in excess of 100 tons. How much over 100 tons do you put in those cars, and would you care to state some heavy tonnages that this equipment has handled when loading your 65-ft car?

A. B. Stoker: I have seen them handle 120 tons (240,000 lb). I checked one 65-ft car, using long structures over the full length, and they had about 180 tons on it. It is quite a bit of overloading. We try to guard against it, but the car is there; they are going to fill it up.

Kenneth Hunt: Do you have an overhead crane to facilitate the assembly of these cars? I noticed a truck crane in one picture. How do you get your parts together?

A. B. Stoker: We have two small mobile cranes known in the trade as roustabouts. We are in the process of remodeling our department which was built up from a shoestring. We are going to have a gantry crane. At present, we are getting ready for the above crane that will span four tracks and a runway 300 ft long. We will do our car maintenance and repairs in the area too.

Kenneth Hunt: What is the heaviest material put into these cars?

E. F. Donatic: The heaviest material is 42-in. slab butts. Those come off a crop conveyor in large boxes and a crane picks them up and dumps them into these cars, so we have to have a strong center sill.

D. A. Bryan: We have found that a used underframe relatively well preserved and one that has not been in heavy industrial usage, having fish belly center and side sills to a depth of 24 to 30 in., will make a good foundation for industrial gondolas or flat cars.

A. B. Stoker: You are very fortunate if you can get a good drop center sill and side car as you describe. Most of the cars available from railroad discards are drop door gondolas with high steel sills and in some cases wood. To strip these down and reinforce for a new body costs more than to construct a new center sill. With new material to weld, it takes two men two days to build a complete center sill with bolsters and lug castings ready to place on the trucks.

D. A. Bryan: I question the use of a two piece floor welded down the center rather than a one piece, ½-in. floor, which may give but will not split in the middle. This tends to strengthen underframe steel running crossways and lengthwise, making one solid unit.

A. B. Stoker: You question the use of a two piece floor. We did too. In fact, I showed the result of abuse to a car built like that. To overcome this we use 8-in. "H"-beams the full width of the car. These plus the channels cushion and protect the center sill.

Another thing—a fish belly or drop center sill to 30 in. depth is what I call an inverted arch. Any fraction of heat to this part of the arch causes it to gradually bow out and down.

D. A. Bryan: Several questions arise on plant usage of gondolas such as the materials loaded into plant cars, what weights are normally handled and can such cars be run over a car dumper to eliminate hand cleaning?

A. B. Stoker: You ask about material loaded in our gondolas that would require hand unloading. This is the dirt and nonmagnetic material that is picked up with scrap and accumulates in the bottom of the car. It takes six to eight months to accumulate it if it is not cleaned out after each trip. In either case it takes manhours to clean out. It has no place in our stockpile where it would end up if it went over the dumper.

D. A. Bryan: On the subject of the new heavy duty cars made within the plant, are these cars made on an assembly line basis? Otherwise, if custom made, does not the cost become prohibitive? Does construction include air brake equipment to facilitate their being used in railroad interchange service?

A. B. Stoker: Yes, our cars are custom built but the cost is much less than if we purchased them outside. We do work on assembly line. One group makes the center sill up to and including bolster. Another group makes the side. Another group assembles and welds the side and bottom. Our design is so simple that we use only car repair men and welders—a layout man part time. We are able to use a lot of short ends from the structural mill and off-gage plate from the plate mill that are headed for the scrap yard. We have cut the welding time down to 300 hours on our gondolas.

We use only hand brakes, as our cars never go into interchange.

D. A. Bryan: Relative to the size and construction of new cars, has consideration been given to shorter cars for industrial use since cubic capacity is rarely a problem? We have questioned on privately owned cars whether 32 or 34-ft length would not allow better construction, less material and somewhat less area to bend or give in hard usage.

At one of our plants we are using a side ventilated or steel stake car for hot crop service, at another plant we have sloped side sheets rather than vertical side sheets. The sloping sides are reinforced on the outside with heavy gusset plates and prevent direct damage when unloading, using a magnet or bucket.

A. B. Stoker: We have quite a number of 30 and 32-ft cars in the yard that were built 10 years ago. They are solid bottoms and slag was put in them to insulate them from heat. Of course more dirt falls in and soon the car is half full. Track and switching time is taken up to handle one-third of a normal load. Cubic capacity is very desirable when you are loading tin scrap, pipe scrap and even plate shearings.

Our cars have capacity and strength and can be used any place in the plant.

We purchased one of the ventilated cars as a test. It has given very good service, but our problem is to keep it in bloom butt service. It very often ends up in the tin mill for a load of tin scrap. The price of these cars hardly warrants buying them. ▲

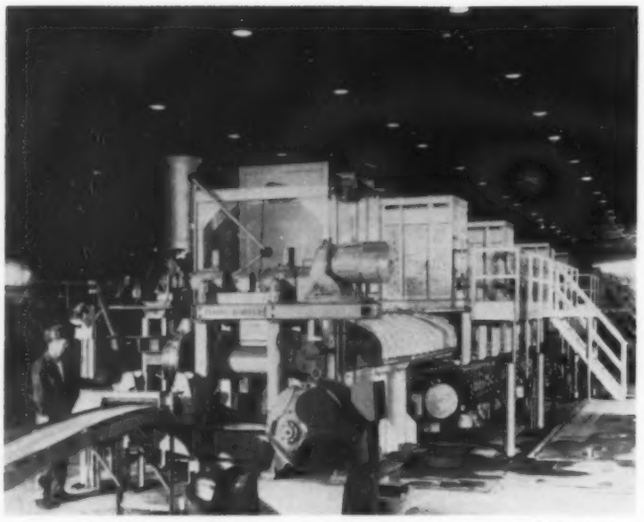


Figure 1 — The furnace on the larger mill is 190 ft-9 in. in length. The furnace on the smaller mill is 155 ft long.

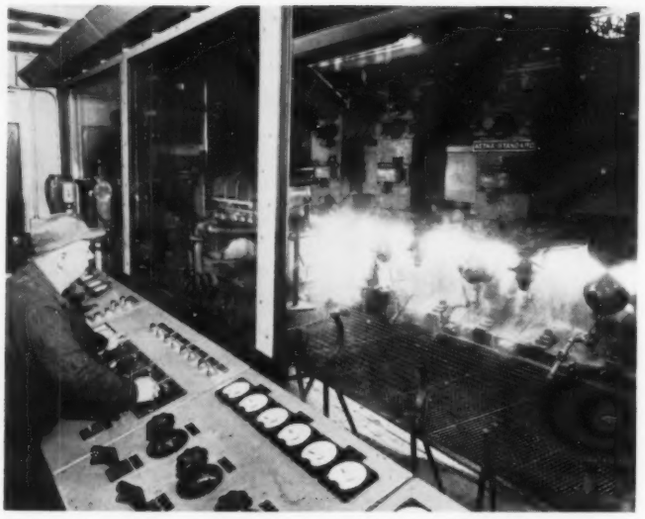


Figure 2 — Operations of the welding and forming stands at the new continuous weld pipe mill are controlled from the operator's pulpit.

Jones & Laughlin Rounds Out Expansion at Aliquippa Plant

THE second of two modern continuous weld pipe mills has been put into operation by Jones & Laughlin Steel Corp. to round out the current expansion program at the Aliquippa, Pa., Works. At a cost of nearly $17,000,000, the new mills include features of advanced design that assure high quality in small-diameter pipe for many applications.

The expansion program at the Aliquippa Works, which has cost $200,000,000 over the past ten years, has increased steelmaking capacity at the plant, and gives J&L greatly-expanded and modernized facilities for production of seamless and welded pipe, tin plate, wire products and strip mill products, and a broader range of structural shapes at Aliquippa.

Facilities added at the plant include two basic oxygen furnaces, a 44-in. hot strip mill, an electric-weld line pipe mill, expanded soaking pit facilities and additions and improvements in many other departments.

The continuous weld pipe mills replace J&L's two butt weld mills, constructed in 1926. The new mills are located on the sites of these older mills in the Aliquippa Works' Welded Tube Dept.

The continuous weld mill just put into operation is capable of producing welded pipe in a nominal size range 1¼ through 4 in. The first mill, completed in 1957, has a size range ½ through 2 in. nominal pipe size.

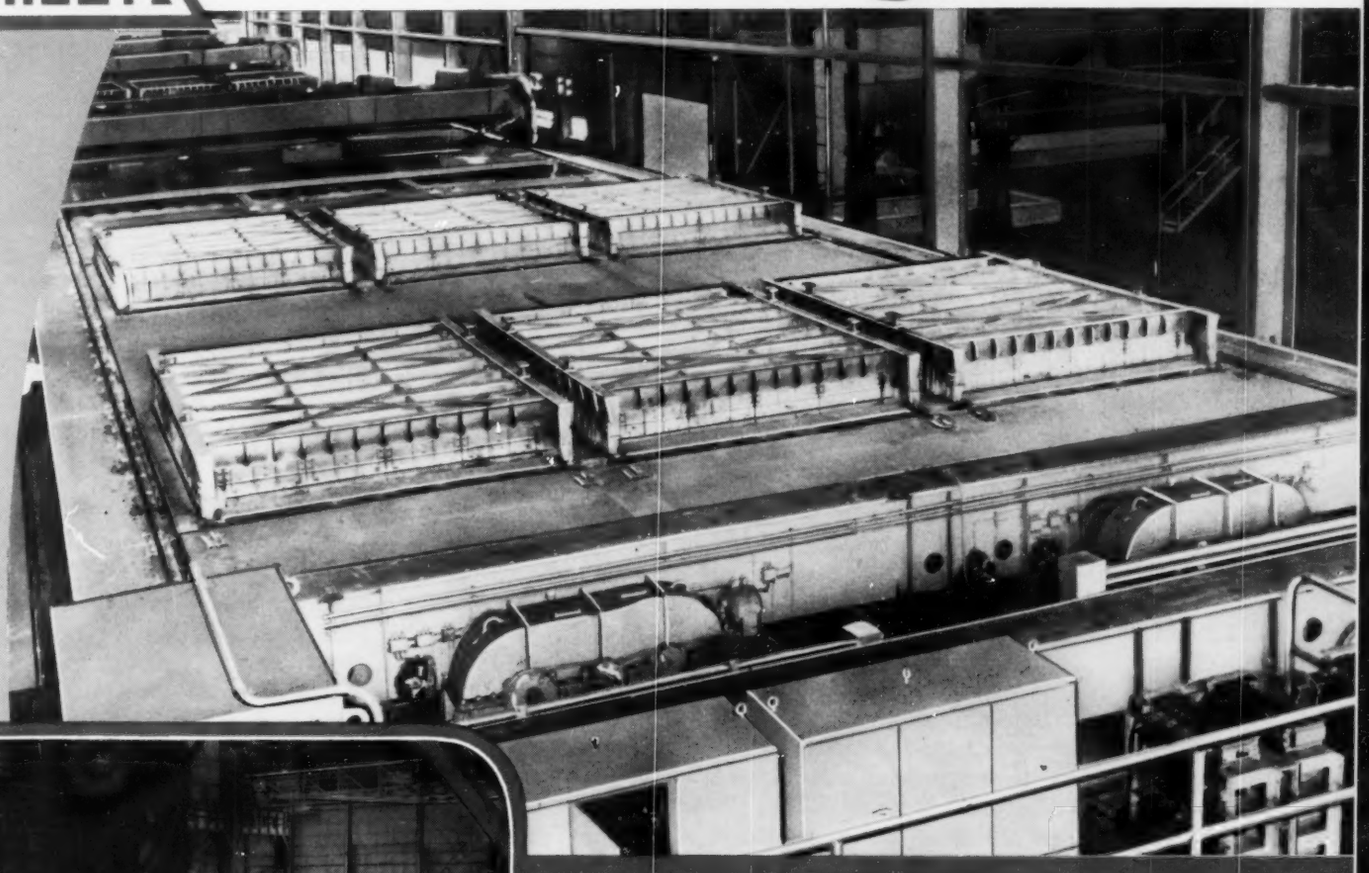
The mills were built by Aetna Standard Engineering Co. and installed by Patterson-Emerson-Comstock, Inc.

Important features of mill give sound weld quality, freedom from heavy scale both on outside and inside surfaces and the physical characteristics that permit coiling and bending.

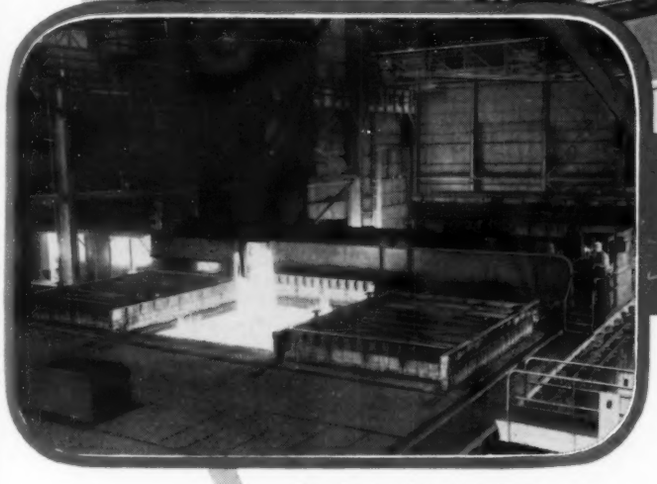
MILL OPERATION

The operation of the continuous weld pipe mills is a complicated process. On the No. 1 continuous weld mill, coiled skelp is placed on an unreeling spool and one end is fed into a roller leveler. As the tail end of one coil is reached, the starting end of another coil is run through the flash welding machine and the two coils joined together to make one continuous ribbon of skelp. After the weld is made, the skelp passes through a trimming machine where the excess metal from welding is removed. The skelp is then payed out by means of pinch rolls to fill up a loop table. This loop table permits welding of succeeding coils without a delay on the production line.

Automatically Controlled Soaking Pits



NINE-HOLE SOAKING PITS designed and constructed for National Tube Division, U. S. Steel Corporation, Lorain, Ohio.



Ingot drawing at a Rust recuperative soaking pit at Lorain Works

The two-way, top-fired, recuperative soaking pits feature completely automatic temperature, fuel air ratio and furnace pressure control. Three batteries of three holes each; hole size: 12′ 6″ wide, 15′ long and 15′ deep. Constructed for Lorain Works, these soaking pits were designed to utilize Rust tile recuperators, which pre-heat air for combustion to 1300°F., resulting in increased efficiency and fuel economy.

Rust Furnace Company, serving the metallurgical industry since 1925, designs, constructs and places in operation all types of furnaces. We are equipped to meet any of your furnace requirements for melting, reheating or heat treating.

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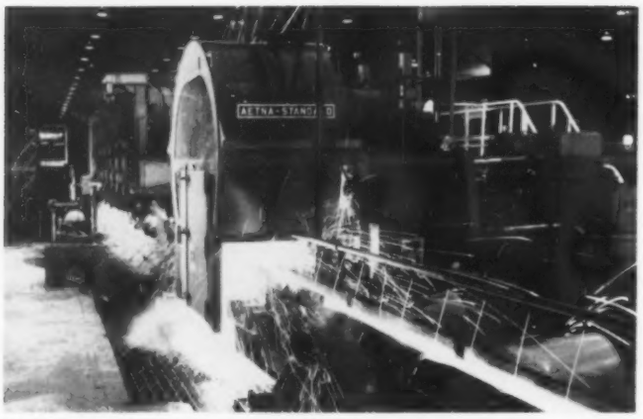


Figure 3 — As the welded pipe emerges from the rolls, it is cut to 42-ft lengths by this flying cutoff saw. The pipe may then be again cut to 21-ft lengths.

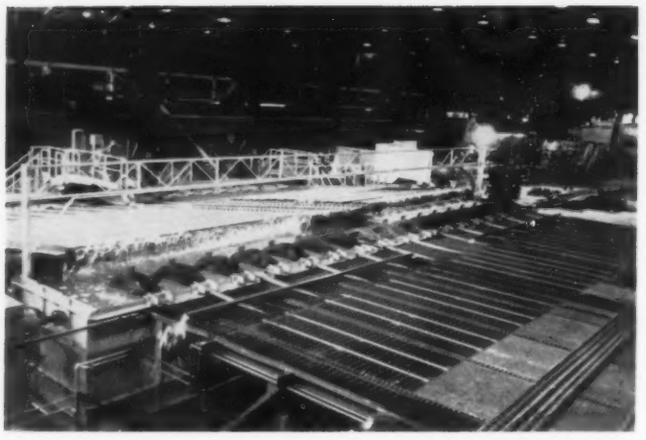


Figure 4 — Pipe is cooled on the cooling rack and in a water bath before it is subjected to various inspections.

The skelp leaves the loop table and enters a 90-ft long preheat furnace, makes a complete loop in this furnace, then comes out and makes another complete loop prior to entering the welding furnace.

The welding furnace is 155 ft long and 33 in. wide. It is fired by small gas burners arranged along each side at intervals of 9 to 10 in. The skelp is brought to a welding temperature of 2450 F in approximately 30 sec in this furnace. However, the center of the skelp is kept several hundred degrees cooler than the edges to provide maximum pressure going through the welding roll.

As the skelp emerges from the furnace, jets of air are played on the edges to remove scale.

The pipe rides through the furnace on raised skids and is not subject to silica scale which adheres to conventional welded pipe whose skelp lies on the furnace hearth.

It then enters the forming and welding mill which consists of 14 stands on this smaller mill. The first stand forms the skelp in a downward curve approximating a circle about 270 degrees closed. This formed skelp then passes through a "welding horn" which keeps it in position as it enters the second stand of rolls or welding pass.

Before the skelp is forced through the welding pass, jets of air are blown on the edges to increase temperature for stronger welds. The edges are squeezed together in the pass thus forming a weld.

After forming a weld, the pipe passes through the remaining stands where it is reduced in size without a change in the wall thickness.

The pipe then is forced through a sizing mill where uniform outside diameter is obtained and then cut to a 42-ft length. It then advances to a splitting saw where the 42-ft length may be cut into single lengths of 21 ft, a standard butt weld length.

It is then carried on a screw-type cooling bed which feeds it into a water bosh for cooling. Following the bosh, the pipe goes to one of two straighteners.

When the pipe has been faced, it is subjected to its initial visual inspection on one of two inspection tables. One table is used for conduit and the other for other types of pipe.

As the pipe is inspected and accepted, it is hydrostatically tested in a new-type Schloemann tester. This tester, manufactured in Germany simultaneously tests five tubes with water pressure up to 3000 psi.

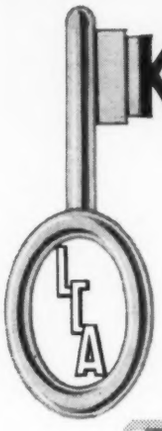
The pipe is then transferred for either direct shipping or additional processing such as galvanizing, threading or coupling.

Material handling is completely automatic in the mills. From the time the skelp enters the welding furnace until it reaches the hydrostatic testers in the form of pipe, all transfers of the material during processing are carried out automatically.

Skelp for the new mills is being produced on J&L's new 44-in. hot strip mill at the Aliquippa Works. The strip mill now processes larger diameter coils weighing as much as 18,000 lb. ▲

Figure 5 — The new continuous weld pipe mills have been equipped with two new-type hydrostatic testers, each of which simultaneously tests five tubes with water pressure up to 3000 psi.

LITHIUM METAL:



Key Constituent in the Alphabet of Alloys

From A to Z the ally of alloys.

From Aluminum to Zirconium Lithium Metal has provided the key to discoveries representing a major scientific break-through in light alloy research. These examples attest to the importance of lithium metal as a product improver.

Aluminum Company of America

Alcoa's new X2020 aluminum-lithium aircraft alloy has pushed ahead by about 100°F. the thermal barrier in supersonic aircraft. It is 3% lighter and has 8% greater elastic modulus which adds to structural stiffness.

Niagara Falls Smelting & Refining Division
CONTINENTAL COPPER & STEEL INDUSTRIES, INC.

Niagara Smelt recommends the use of their "FALLS" 5% Lithium Aluminum Master Alloy to reduce porosity in aluminum die casting alloys. Unexcelled as a deoxidizer and degasifier for copper, bronze and bearing alloys is their "FALLS" 2% Lithium Copper. It produces a strong, dense, highly electrically conductive casting. And cuprous oxide in copper and copper-base alloys is best deoxidized with Lithium Copper Cartridges.

Handy & Harman

H. & H. supplies brazing alloys of lithium-silver and lithium-silver-copper for joining stainless steel and titanium alloys. Its strong deoxidizing effect on the oxide coating of the metal increases the alloy's wetting character. Melting point is also reduced, and lithium's self-fluxing effect eliminates the need for chemical fluxes in reducing or inert atmosphere brazing.

Wall Colmonoy Corporation

Wall Colmonoy uses lithium metal to braze titanium and zirconium parts. Li in the form of a metal vapor atmosphere is used as a deoxidizer for oxygen, causing good wetting and flow. The brazing is accomplished at 1400-1600°F., remarkable since the melting point of the silver used is over 1700°F. Lithium as a gas flux plates the surfaces with silver, making soldering possible using any standard silver type. The process admirably lends itself to commercially pure titanium where it is necessary to stay under the transformation temperature of Ti.

Lithium treatment will improve processing of most metals and alloys. New methods of application are broadening its use by industry. We offer cooperative study on your problems. Your request on company or institutional stationery will receive prompt attention.

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Figure 1 — New Republic bar mill represents an investment of over $18,000,000.

Republic Starts Operation on 11-In. Bar Mill at South Chicago

THE new 11-in. bar mill recently put into operation by Republic Steel Corp. at South Chicago, Ill., contains many advanced design features. Representing an investment of more than $18,000,000, the mill produces alloy and carbon steel bar products $\frac{3}{8}$ to $1\frac{1}{4}$ in. in diameter and equivalent sizes of squares, hexagons, special sections and concrete reinforcing bars, as well as flats 1 to 4 in. wide.

Billets (3 in. or 4 in. squares) are heated in a continuous two-zone, sloping hearth furnace rated at 85 tons per hr. Natural gas or fuel oil is used, with automatic changeover from one to the other.

The mill consists of 16 stands in straightaway layout. The eight stands in the roughing section are alternately vertical and horizontal roll stands. The eight finishing stands are alternately horizontal and vertical. Thus, twisting or turning the steel is unnecessary. Vertical looping is used between the finishing stands.

Each roll stand is individually driven with d-c motors ranging from 300 hp on the first stand to 800 hp on the last stand. Motors for the horizontal roll stands are on the main floor. Vertical roll stand motors are located below the main floor. All drive motors draw power from two 3500-kw generators driven by a 9800-hp motor.

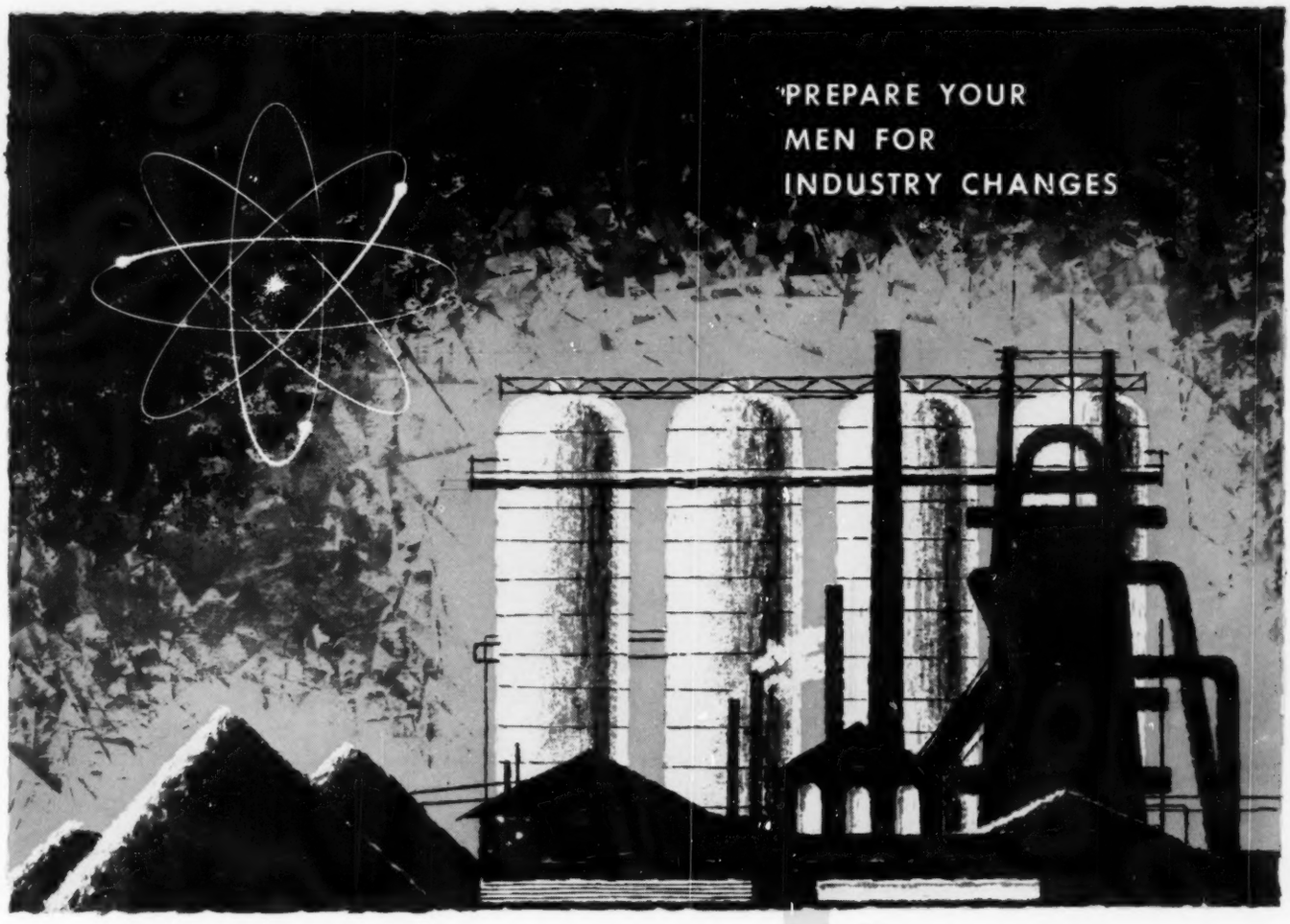
Maximum delivery speed of the mill is 3000 fpm.

Sixteen extra roll stands, complete with rolls and guide equipment, expedite mill changes.

Lubrication is provided by four circulating oil systems and five automatic grease systems. Roller bearings are used on the roll necks.

Leaving the last stand of the mill, bars may pass on to one of the two cooling beds or they may be formed into coils weighing 450 to 1600 lb.

The new mill enables Republic to compete in several new Market areas. ▲



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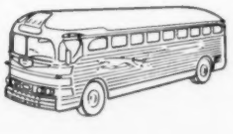

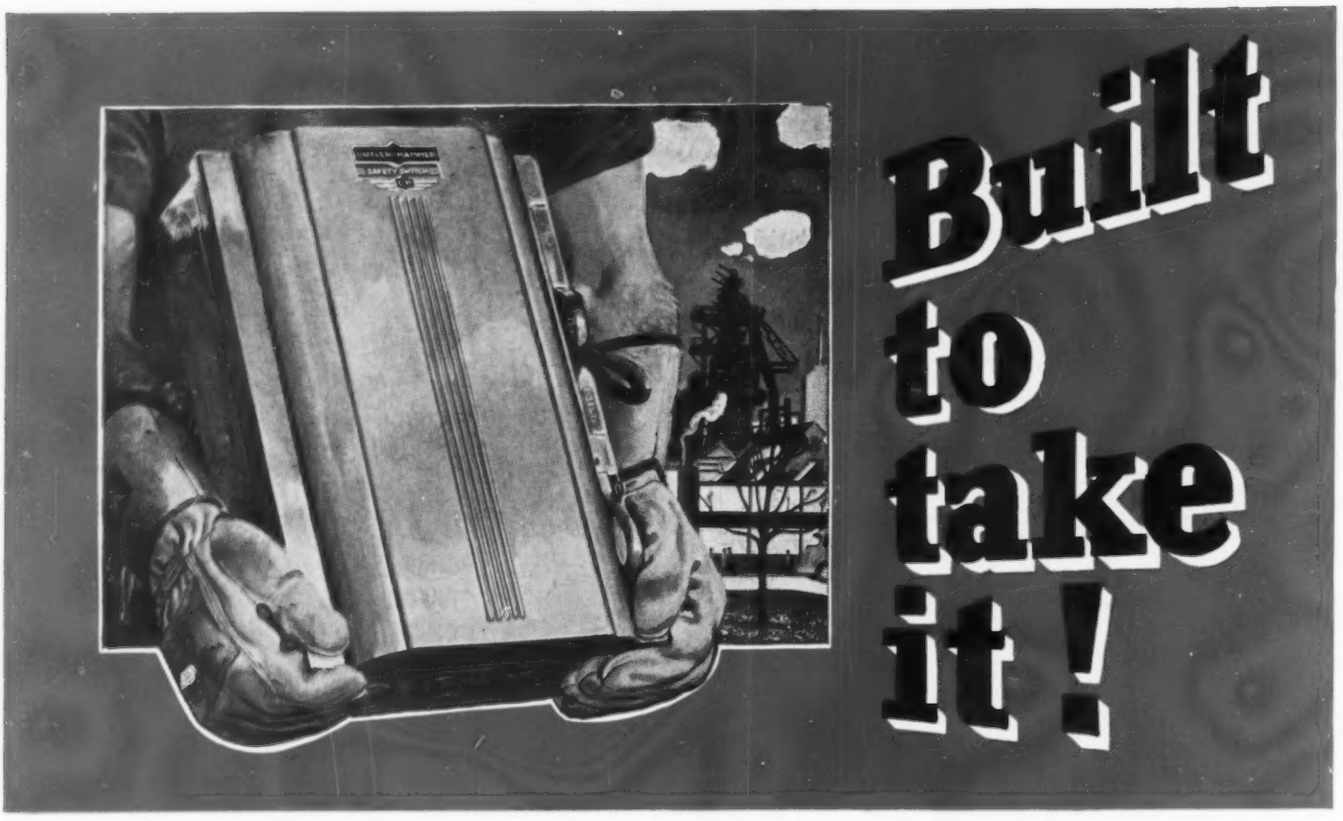

CUTLER-HAMMER'S 4105 TYPE A SAFETY SWITCH WITH DUO-STRENGTH OPERATING HOOKS ADDS NEW SAFETY TO SAFETY SWITCH PERFORMANCE

This is the finest, most modern safety switch . . . the new Cutler-Hammer 4105 Heavy Duty Type A Safety Switch. Tested and proven superior, the new C-H 4105 combines the famous C-H "heat proof dependability" with a new high-strength construction for safer, positive switch performance. Plant electricians, engineers and contractors solidly recommend and install Cutler-Hammer 4105 safety switches for every heavy duty application, and here's why.

The new duo-strength operating hook and hook insulator insure the dependable performance so vital to reliable safety switch operation. The hook is made of high-strength steel and the insulator of glass fibre Alkide, known for its exceptional dielectric strength. The all-steel linkage between the contact blades and operating handle will faithfully open and close the switch blades even after years of continuous service. The Alkide hook insulator and operating rod insulating sleeve provide double insulation for double-sure safety.

Other important features of design include new automatic pressure fuse receivers; no screws to tighten . . . fuse can't work loose or be left loose while in service. Visible contact blades for quick, sure inspection at all times. Panel mounted mechanism of this new 4105 safety switch is readily interchangeable with that of the previous 4101 design for rapid replacement without case-and-conduit work.

4105 safety switches are available in sizes from 30 amperes to 1200 amperes; 2, 3, and 4 poles; fusible and non-fusible. Order from your nearby Authorized Cutler-Hammer Distributor today, or write for the C-H Merchandiser EA-100-R232 . . . a handy selection guide.

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Sub-base panel mounting simplifies maintenance . . . quick, sure, economical. New 4105 mechanism will fit 4101 style case; no new case or conduit work.

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Strip Preheat Ends Galvanizing Pot Downtime

by Edward J. Udick,
Superintendent of Sheet Mill
Weirton Steel Corp., Division of National Steel Corp.
Weirton, W. Va.
and Charles A. Turner, Jr.
Chief Metallurgist
Selas Corp. of America
Dresher, Pa.

WEIRTON Steel Co., division of National Steel Corp., has improved the quality of its soft, continuous-coated galvanized steel sheet and reduced equipment maintenance costs through the use of an unusual direct-fired strip preheating furnace integrated into their No. 1 galvanizing line at Weirton, W. Va. By preheating to 950 F without oxidation, this furnace, designed and built by Selas Corp. of America, has permitted Weirton to eliminate strip fluxing and maintain the required zinc bath temperature without external pot firing.

The new method has been successful in its primary purpose: to extend pot life. In addition, it has resulted in low aluminum addition requirements, negligible dross formation in the bath and improved coating adherence. Higher product quality permits application of the coated sheet —"Weircoloy"—to the most difficult forming operations.

CONTINUOUS GALVANIZING METHODS

Most of the continuous galvanizing lines in operation today incorporate the annealing treatment with the coating process, handling coils directly from the rolling mills. The balance of the lines are basically limited to coating only, handling coils batch-annealed as a prior operation. The Weirton No. 1 line falls into this latter category.

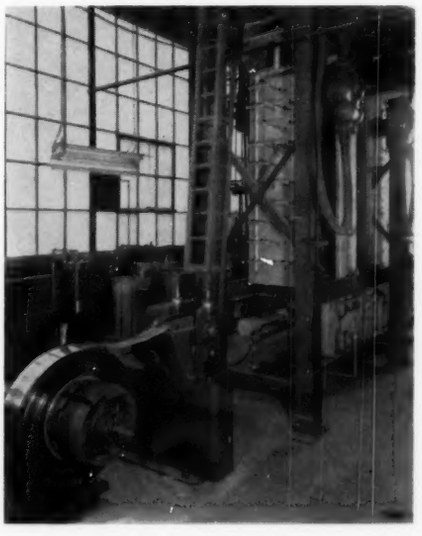
Annealing in the line develops good formability, though the product may be stiffer than batch-annealed material. Annealing out of line permits a galvanized product ranging between full soft and full hard to meet a full range of consumer demands. By either method, the coating is characterized by good adherence, capable of withstanding all drawing and bending operations involved in fabricating. This results primarily from the use in the zinc bath of aluminum (0.15 per cent) to suppress formation of the brittle iron-zinc alloy layers in the coating.

STRIP GALVANIZING INSTALLED

In 1948, Weirton Steel Co. installed a hot dip strip galvanizing line to obtain benefits not previously achieved by processing of individual sheets. This line, like other similar lines handling batch-annealed coils, employed cleaning of the strip and liquid fluxing. The aqueous flux was dried and partially preheated in passage through a radiant tube furnace before immersion in the molten zinc. The balance of the heat required in raising the strip temperature to the zinc bath temperature of 850 F was supplied by external firing of the steel pot with multiple natural-gas burners. Average production of light gage material was 7 to 8 tons per hr.

During the early stages of operation, attempts were made to improve the forming characteristics of the coated sheet by adding aluminum to the bath. In the presence of

Figure 1 — Pilot strip furnace in Selas laboratory was operated with galvanizing bath to develop continuous strip preheating process.



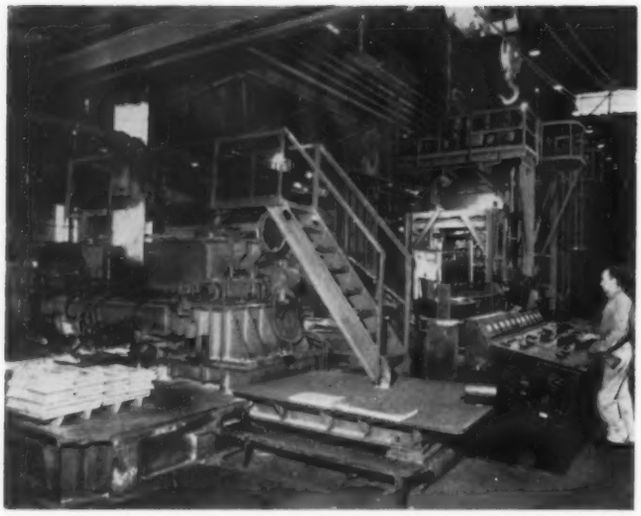


Figure 2 — No. 1 galvanizing line at Weirton Steel Co. The Selas preheat furnace is at right, delivery duct is under walkway, and zinc bath at left. Ingots at extreme left are added cold to the bath when necessary.

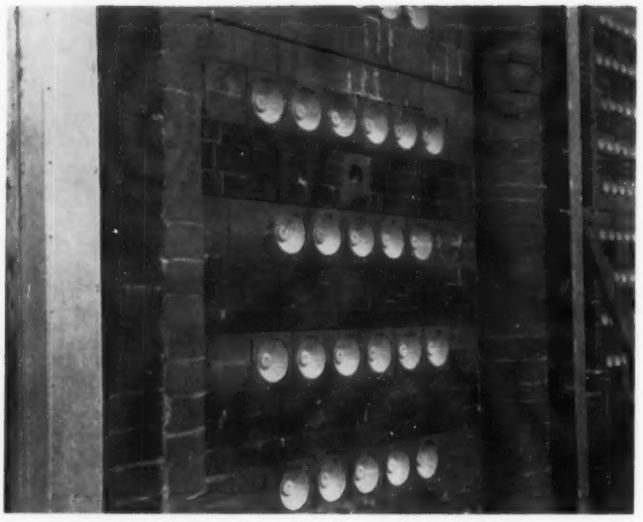


Figure 4 — Pattern of radiant burners of the type used in galvanizing preheat furnace produces uniform temperature in strip.

the flux, the aluminum attacked the steel pot at a rapid rate, necessitating repairs every few days. On this basis, aluminum additions were eliminated, resulting in a product restricted to such applications as roofing sheet, where the light forming involved minimized the requirement of good coating adherence. However, this coating method resulted in frequent shutdowns for pot repairs (approximately two days every six weeks) and removal of bottom dross each week.

Weirton approached Selas Corp. for consideration of improved pot firing as a solution to their pot life problem. Selas engineers suggested that the strip be preheated to 950 F by direct-gas firing for elimination of all pot firing during line operation. Further, this approach would eliminate fluxing and permit improved coatings through the addition of aluminum to the molten zinc bath.

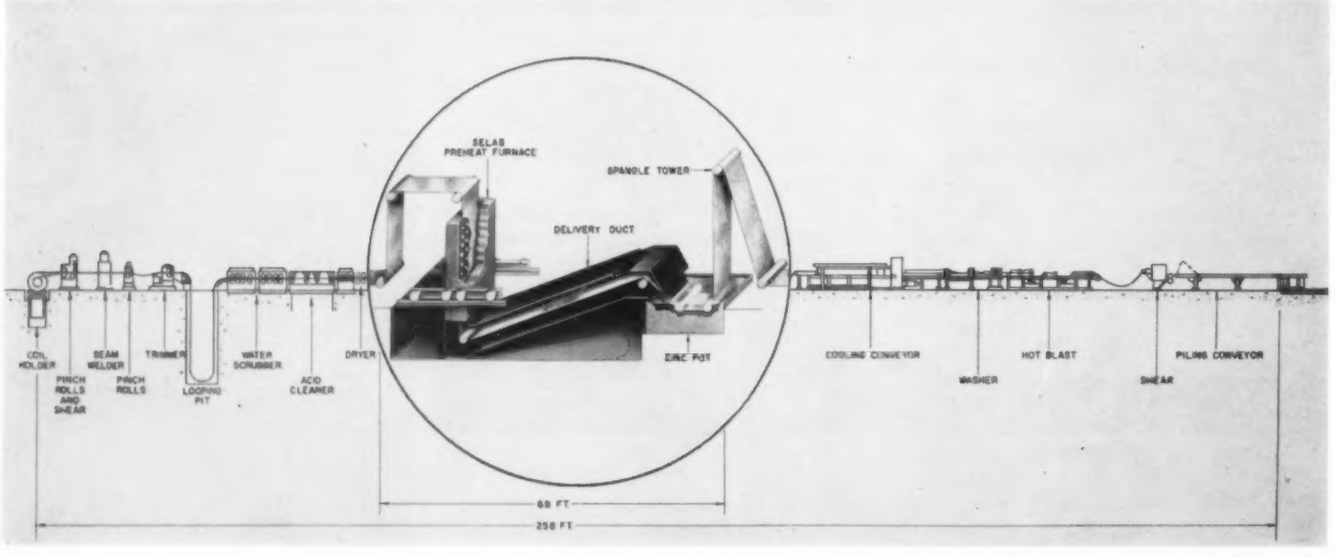
To prove the feasibility of this method, tests were run in the Selas laboratory on the pilot line shown in Figure 1 (modified to provide a coating bath). Based upon successful pilot operation, the production furnace shown in Figure 2 was designed and installed in 1954. This unit, consisting of furnace and delivery duct, replaced the fluxing equipment and radiant tube drying furnace and was fitted as shown in Figure 3 into 69 ft available between strip cleaning equipment and the spangle tower. A smaller zinc pot was substituted, but the balance of the line equipment remained in its original position.

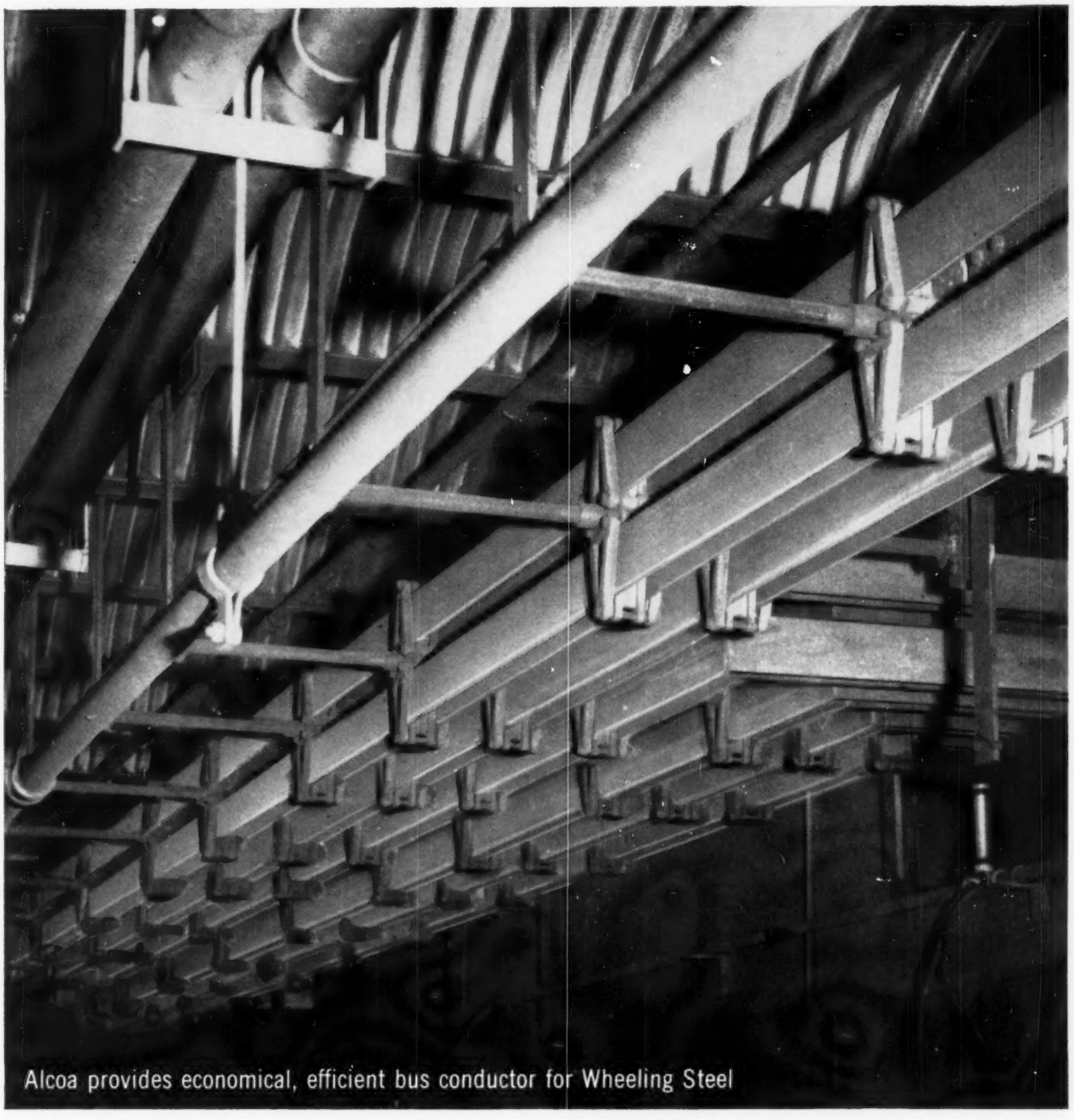
PREHEATING FURNACE DESIGN

The furnace consists of two retractable, vertical panels similar to those in Figure 4 which, in closed position, form a tight chamber 16 ft high by 5 ft deep by 15 in. wide. The strip enters at the top cold and exits at the bottom, through seal rolls, at approximately 950 F. When the line is stopped, the panels retract automatically to avoid overheating of the strip.

Each panel is studded with Duradiant cup-shaped burners fired by premixed gas and air whose ratio is closely controlled to avoid free oxygen in the furnace gases. Combustion takes place within the ceramic cup as shown in Figure 5, developing high incandescence and a high heat transfer rate, principally by radiation.

Figure 3 — On No. 1 galvanizing line, the preheat furnace and new zinc pot were installed without altering the balance of the line.





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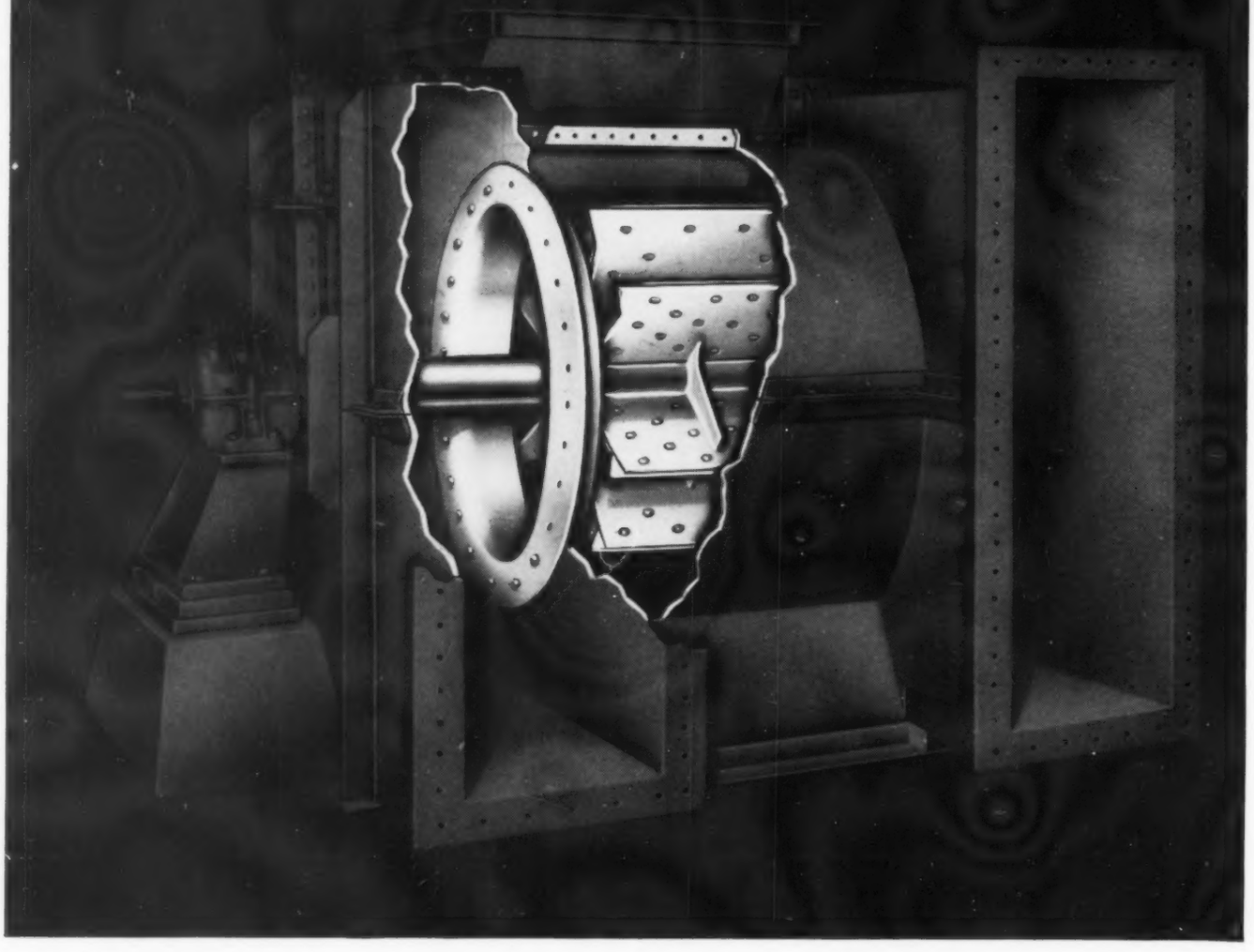

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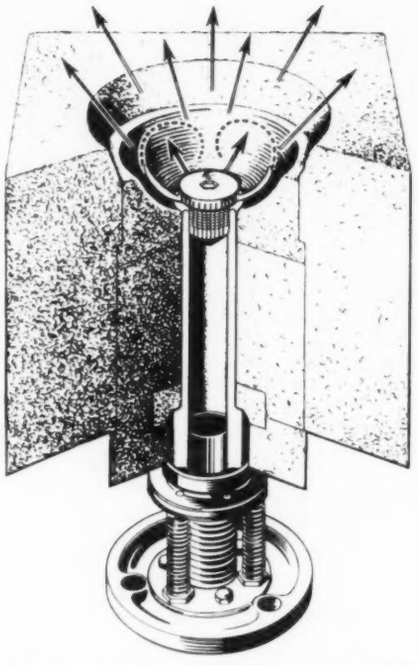


Figure 5 — Burner employs ceramic cup against which flame sweeps (dashed line) producing incandescent surface for radiant heating (arrows) without flame impingement.

The strip entering the furnace has been cleaned by acid pickling and drying in the line. No oxidation results in heating this strip to 950 F due to the composition and high temperature of the gaseous products of combustion, in combination with the short exposure time to these gases.

The strip, leaving the furnace at the bottom, enters a chute connecting the furnace and the pot. This chute, provided with an externally prepared protective gas, prevents oxidation of the strip. Electric heating elements (one of which is shown in Figure 6) on the inner walls aid in maintaining strip temperature of 950 F in passage through the chute. During production runs, power consumption is slight and, therefore, the elements serve principally to maintain chute temperature during startups or line stoppages.

Furnace specifications are as follows:

Rated production	24,000 lb per hr (based on 24 gage strip, 33 in. wide, at 138 fpm)
Speed range, fpm	56 to 225
Gage range	18 to 30
Strip width range, in.	24 to 48
Strip temperature, furnace exit, F	950

All temperature and fuel control instruments are grouped in the control panel shown in Figure 7.

IMPROVED PRODUCTION

The compactness of the furnace and the firing method permit fast startups from cold (15 min). Heating time to 950 F varies between 4 and 17 sec over the specified speed range. Production figures of 6500 tons per month compare quite favorably with former figures of 4500 to 4700 tons per month.

Preheating of the strip to 950 F at the point of bath entry has accomplished the major aim of this line revision: improved pot life and elimination of downtime for pot repairs. In fact, since the start of operations late in 1954 no repairs have been made. The pot was cleaned out after two years of operation, found to be in satisfactory condition, and placed back in service. Dross formation is practically nil, and, currently, it has not been found necessary to make a bottom removal over the past eight weeks. No pre-melting of the zinc slabs is necessary and they are fed directly into the bath.

Right from initial operations, Weircoloy, the product of this Selas preheat line has demonstrated its ability to take the severest draw or bend without peeling or cracking of the coating. The microstructure of this product, shown in Figure 8, reveals a uniform coating thickness with but a light alloy layer at the interface. This has permitted its application to pipe, gutters, pails, covers and other items requiring sheet meeting the requirements of the Pittsburgh lock-seam test. ▲

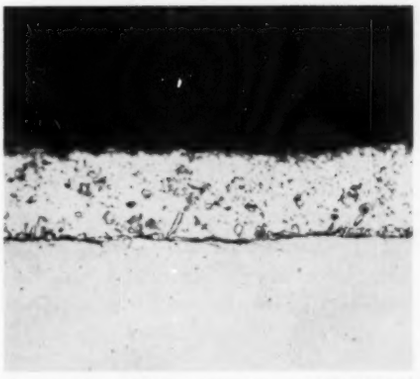


Figure 8 — Microstructure of finished product (500X) reveals uniform coating thickness with but a light alloy layer at the interface.

Figure 6 — Electric heating elements are employed to hold temperature in delivery duct.

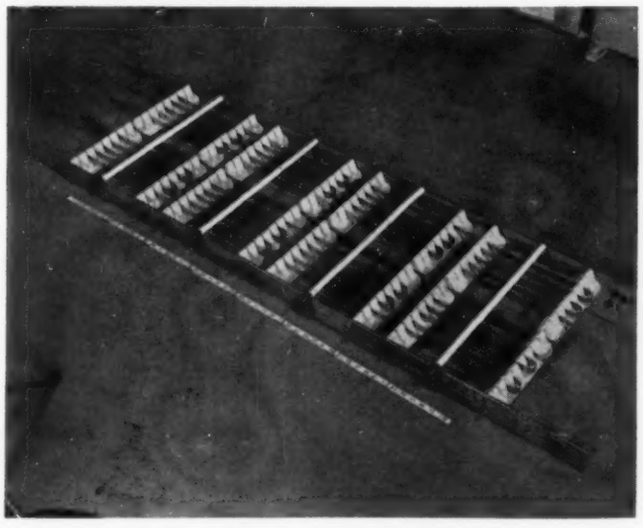
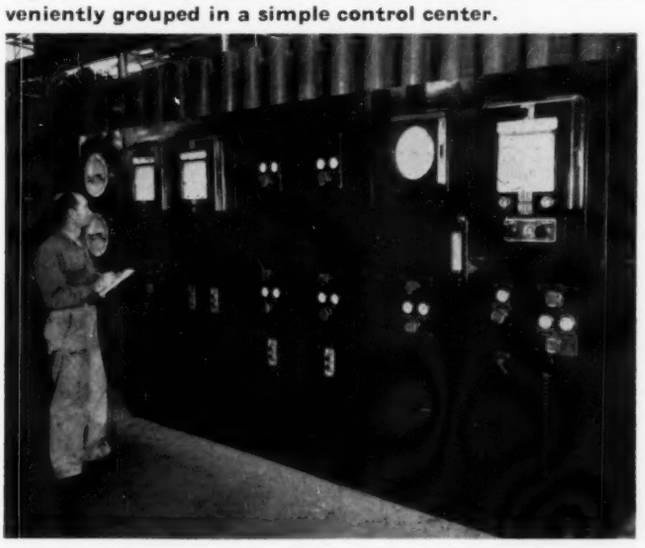


Figure 7 — Temperature and fuel instruments are conveniently grouped in a simple control center.



Machine Peels Ingots in In-Line Operation

A NEW machine has been recently announced by the Innocenti Corp. to condition ingot surfaces before rolling. The Innocenti hot peeling machine utilizes a radically new approach to the age-old question of removing surface defects. By working directly on hot ingots, this machine does the following:

1. Eliminates the cooling process after stripping with consequent conservation of heat energy.
2. Eliminates the annealing treatment often required prior to cold surface preparation.
3. Reduces surface preparation time because of the high cutting speeds and feeds possible on hot metal.
4. Reduces milling power requirements due to increased plasticity at elevated temperatures.
5. Greatly simplifies the materials flow through the plant.
6. Improves the metallurgical characteristics in the finished steels.

The hot ingot peeling technique was developed originally for the preparation of alloy steels (including stainless), which for various reasons could not be flame scarfed. Both the method and the peeling machine have proved highly successful in producing a superior quality in the finished steel as well as substantially lowering production costs.

After the ingot has been stripped from its mold (about 1450 F), it is heated to 2200 F and sent to the hot ingot peeling machine for milling of the four faces. During the peeling process, there is a loss of temperature ranging between 100 and 200 F. The ingots are then returned to the furnaces where this loss is restored and the conditioned ingot is at rolling temperature ready for finishing.

With such a simplified cycle, this combination of new technique and machine yields substantial savings in materials handling costs, in heat energy costs, as well as processing time and direct labor costs. In addition, although of less major significance, the milled chips are reclaimed and returned for reuse.

The hot ingot peeling machine consists primarily of four sections: (1) the milling cutter; (2) bed and carriage; (3) manipulator and tables; and (4) hydraulic power group and control panel. Of special interest is the milling cutter wheel which is 7 ft in diam. It is of cast steel and contains 48 cutting tools on the periphery. The wheel, rotated at 75 rpm, produces a cutting speed of about 1700 fpm. Heat transferred to the cutting tools during direct contact with the hot ingot is dissipated by cooling water spray, and

Figure 1 — Hot ingot peeling machine was developed originally for alloy and stainless steels.

Figure 2 — Peeling machine is built in two standard sizes: one for 3-ton, the other for 5-ton ingots.

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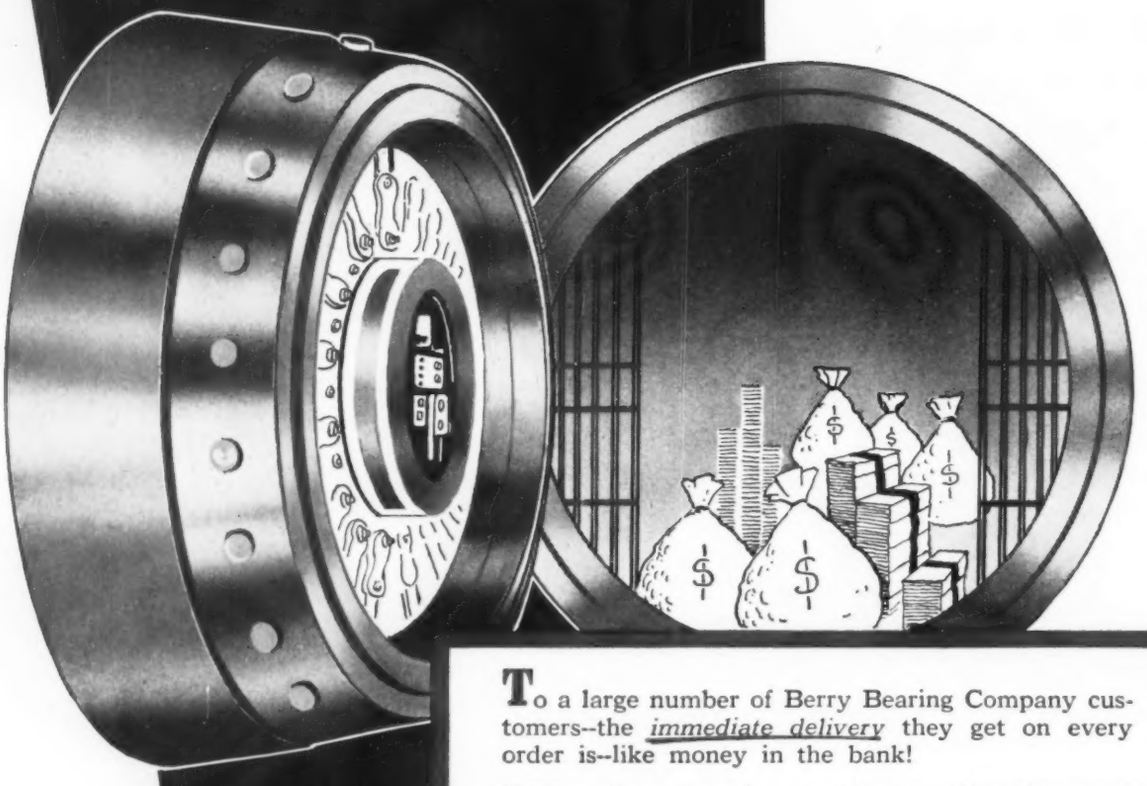

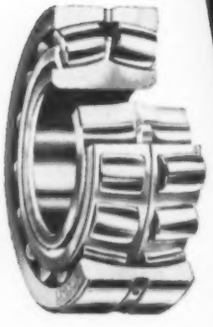

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as the ratio of tool time in contact with the ingot to tool time at rest is 1 to 47, the temperature of the cutting tools remains at about 200 F.

An idea of working time of the ingot conditioning process can be gained from the following: the combined time for all operations excluding the surface milling is a relatively constant figure and is approximately 90 sec. This figure includes the ingot loading, locking, four quick-return motions, manipulating and unloading operations. The actual surface milling time depends upon several factors, such as length of ingot, temperature, physical characteristics of the steels, but results show that for a 4-ton ingot, it can be machined in as little as 35 to 40 sec per face. This indicates a production rate of 13 ingots per hr. Innocenti Corp., however, suggests that there should be no difficulty in maintaining a regular production rate of 10 ingots per hr.

At present, Innocenti is manufacturing the hot ingot peeling machine in two sizes: one for 3-ton and one for 5-ton ingots. The following tabulation gives some of the features and performance data of these machines.

This new method, using the hot ingot peeling machine, constitutes a major technological advancement in the production techniques for alloy and stainless steelmaking. ▲

TABLE I

	Model FCL 3	FCL 5
Maximum ingot weight, net tons	3.3	5.5
Maximum ingot face, in.	22	26
Maximum ingot length (including gate), in.	67	87
Cutting wheel diam., in.	85	85
Feed speed, in. per min.	40 to 120	40 to 120
Quick return speed, in per min.	100	100
Cutting wheel motor, power kw	330	600
Auxiliary motors, power kw	100	150
Machine weight (excluding motors), net tons	125	190

Tube Mill Practice

A selection of articles from the IRON AND STEEL ENGINEER on various phases of tubemaking.

(Published in 1953)

Practical information on layout and operation of facilities for seamless, butt and electric weld pipe, a field in which little information has been published...23 articles by 20 authoritative writers ...invaluable for engineers, operators, trainees and students.

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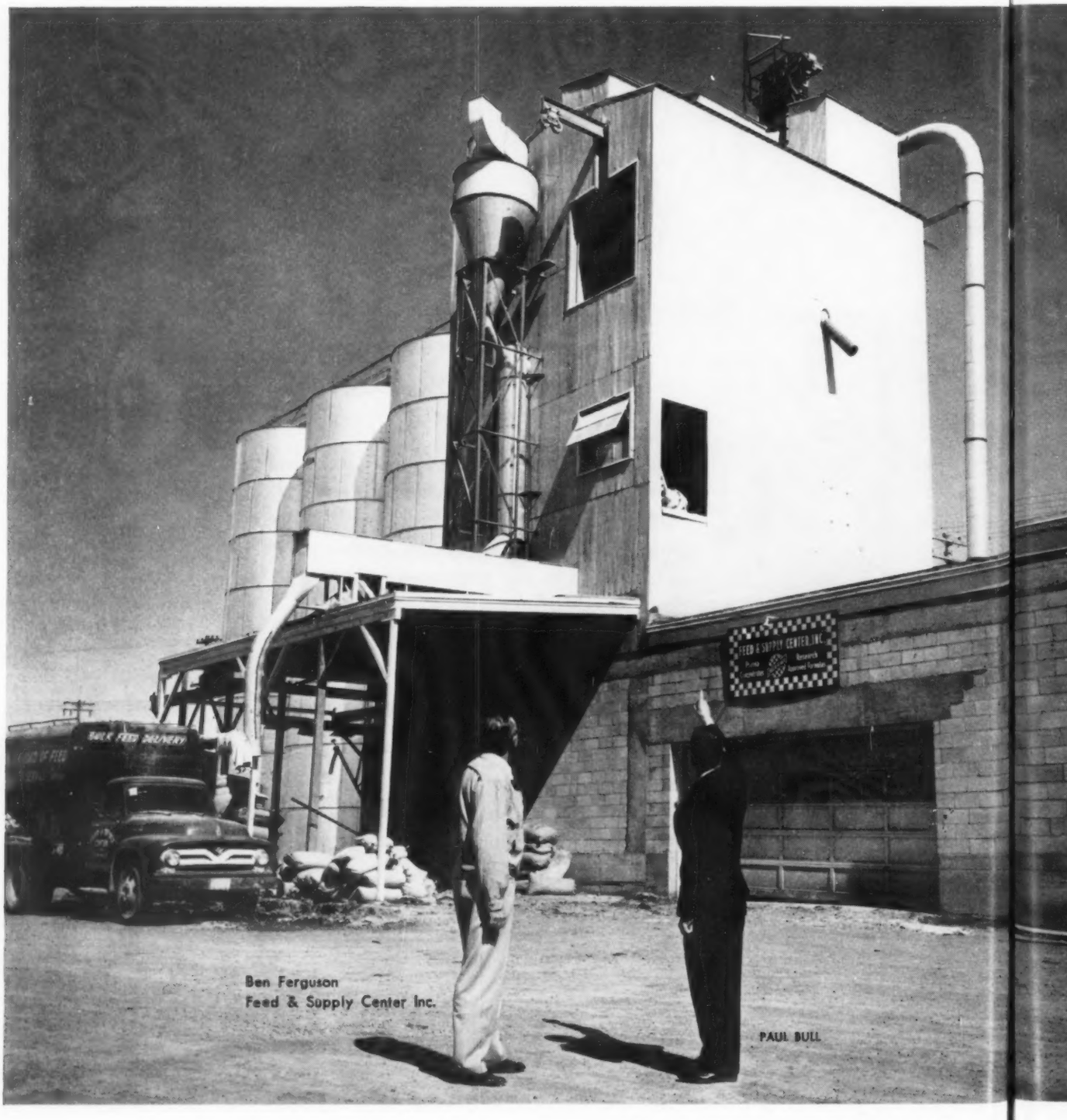
"A bent shaft on an elevator motor might have caused a terrible accident

. . . if Fusetron dual-element Fuses had not shut down the motor"

PAUL M. BULL, Commercial,
Industrial Representative
Idaho Power Co., Twin Falls, Idaho



Ben Ferguson
Feed & Supply Center Inc.

PAUL BULL

Mr. Bull continues:

"As a Commercial and Industrial Representative for the Idaho Power Co., I was asked to redesign the electrical work for the Feed & Supply Center Inc., Twin Falls, Idaho. The installation was handled by Detweiler, an electrical contractor.

"When the job was completed, Fusetron fuses kept blowing on a 15 hp., motor that operates the elevator.

"Larger size Fusetron fuses were tried and the result was almost disastrous.

"When the motor started the whole elevator shaft shook as if it would tear apart. Everyone was afraid that at any second the motor and apparatus would come crashing down the shaft.

"Fortunately, the Fusetron fuses opened and stopped the motor.

"A thorough check revealed that the shaft of the motor was bent in transit.

"If Fusetron fuses had failed to open to protect the motor, there might have been a terrible accident."

You too, can benefit by the 10 point protection of Fusetron fuses.

Fusetron dual-element fuses offer the safest, most complete electrical protection possible. With rare exceptions on commercial and industrial installations — ordinary fuses and circuit breakers protect only against short-circuits — but Fusetron dual-element fuses provide 10 point protection.

Why Risk Losses! One burned out motor . . . one needless shutdown . . . one destroyed switch or panel . . . one burned out solenoid . . . may cost you far more than replacing every ordinary fuse with Fusetron dual-element fuses.

BUSS Hi-Cap Fuses—High Interrupting Capacity above 600 and up to 5000 amperes

BUSS Hi-Cap fuses offer unlimited interrupting capacity for circuits of 600 volts or less. Their high speed operation on heavy shorts limits current to safe values. This minimizes damage to equipment and cuts down dangerous stresses on transformers.

These fuses can be coordinated with Fusetron fuses to isolate fault to circuit of origin.

BUSS Limitron Fuses — Limits Fault Current to Very Low Values

BUSS Limitron fuses have extremely fast opening characteristics to prevent heavy short-circuit currents from building up under fault conditions.

For more information write for —

Bulletin FIS *on Fusetron dual-element fuses.*

Bulletin HCS *on BUSS Hi-Cap fuses.*

Bulletin HLS *on BUSS Limitron fuses.*

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University at Jefferson,
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Play Safe! install FUSETRON dual-element FUSES and BUSS Hi-Cap FUSES throughout entire Electrical System!

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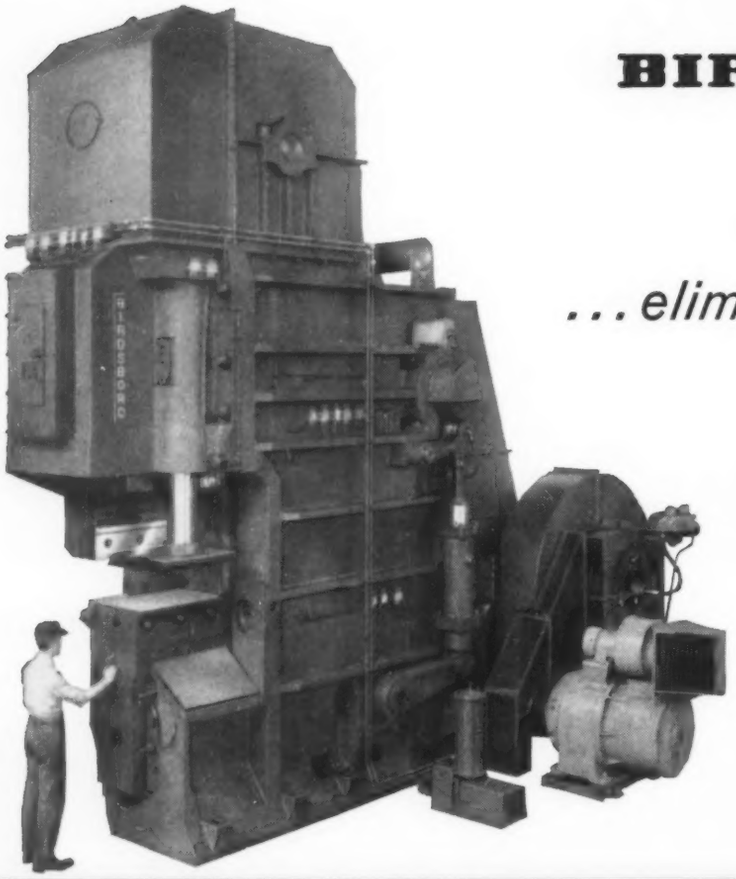

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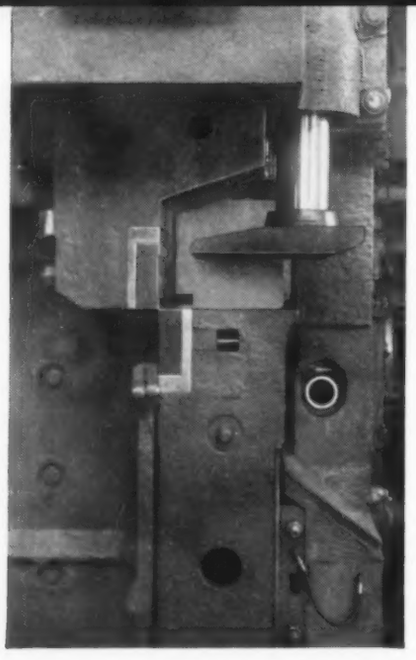
Schematic view of Birdsboro Bloom & Slab Shear in action

Hold-down gag clamps piece firmly against bottom knife

Shearing action is completed with rising stroke of bottom knife and gag



You can learn more about this job-proven shear and other recent Birdsboro developments from your nearest representative or: *Main Office, Engineering Department and Plant:* Birdsboro, Pa., *District Office:* Pittsburgh, Pa.

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Date-line Diary...

July 2

Δ Phelps Dodge Corp. increased its price on copper 1½¢ to 26½¢ a lb.

Δ Lead prices fell ½¢ to 11¢ a lb in New York.

July 3

Δ Government figures showed that construction outlays rose seasonally in June; expenditures were over $4,300,000,000, up $322,000,000 over May, 1958, and $49,000,000 below June, 1957.

Δ Salaried employees at Lukens Steel received an across-the-board increase of 4½ per cent effective June 29, and will receive an additional 1½ per cent cost-of-living increase on July 13.

July 5

Δ The AISI reported that shipments of finished steel products for May, 1958 totaled 4,649,499 net tons compared with 4,372,971 in April and 6,972,091 tons in May, 1957.

July 7

Δ The AISI reports estimated payroll for the iron and steel industry for May, 1958, amounted to $257,965,765, compared with $247,433,391 in April, 1958 and $322,790,329 in May, 1957. Estimated total employment was 500,369 compared with 502,653 in April. Average hourly payroll cost per wage earner was $3.095 compared with $3.108 in April and $2.824 in May, 1957.

Δ The AISI reports that the operating rate of the steel industry for the week of July 7 is scheduled at 1,459,000 tons (54.1 per cent of capacity). This compares with 1,376,000 tons (51.0 per cent of capacity) one week ago and 2,015,000 tons one year ago. Index of production for the week is 90.8.

July 8

Δ President Eisenhower signed a bill granting statehood to Alaska. Date for Alaskan plebiscite has not been set.

Δ Alan Wood Steel Co. backtracked scheduled price increases to stay competitive because other mills did not raise prices to offset the mid-year wage increases.

Δ International Nickel Co. of Canada is cutting nickel production an additional 20 per cent, which amounts to a slash of about 50,000,000 lb down to an annual rate of 200,000,000 lb monthly.

Δ The Bureau of Mines reported that production of Pennsylvania anthracite for June, 1958, equalled 1,998,000 net tons compared with 1,639,000 in May, 1958, and 2,564,000 tons in June, 1957.

Δ The Bureau of Mines, U. S. Department of the Interior, reported that production of iron ore in the United States for March, 1958, totaled 3,012,000 long tons; shipments 1,411,000 long tons; iron ore imported for consumption in the United States totaled 1,491,834 long tons.

Δ The Bureau of Mines reported that the consumption of scrap during May, 1958 totaled 3,861,000 gross tons, pig iron used was 3,693,000 gross tons; this compared with 3,429,191 tons of scrap and 3,378,893 tons of pig iron in April, 1958.

July 9

Δ Government figures showed that employment in manufacturing industries increased to 15,200,000 in mid-June, 150,000 above the month-earlier level; total employment totaled 64,900,000 an increase of 920,000.

July 10

Δ Ford Motor Co. reduced its common dividend to 40¢, compared with 60¢ dividends declared in previous quarters since sales of stock were available to the public.

Δ Prices of steel scrap in the Pittsburgh district edge up $2 a ton, with light sales of No. 1 heavy melting scrap at $38 and No. 2 bundles at $28 a ton.

July 11

Δ The Agricultural Dept. reported that present indications for crop production for 1958 are that it will equal 106 per cent of the 1947–49 average.

July 14

Δ The Labor Dept. reported that new claims for unemployment compensation jumped by 100,900 to a total of 467,200 in the week ended July 5. In 1957 the increase in new claims rose 103,600 to 339,300.

Δ GE reports that sales billed during the first half of 1958 amounted to $1,978,994,000 compared with $2,121,310,000 in 1957; earnings totaled $103,381,000 or $1.18 a share, compared with $1.47 per share for the same period in 1957.

Δ The AISI reports that the operating rate of the steel industry for the week of July 14 is scheduled at 1,515,000 tons (56.1 per cent of capacity). This compares with 1,442,000 tons one week ago (53.4 per cent capacity) and 2,030,000 tons one year ago. Index of production for the week is 94.3.

July 15

Δ The Labor Dept. reported that private home starts in June climbed to a seasonally adjusted annual level of 1,090,000, which compares this 1,010,000 in May, 1958 and 995,000 in June, 1957. For the first half of of 1958, the adjusted rate was 983,800, slightly above the 1957 period.

July 16

Δ A new issue of $300,000,000 United States Steel Corp. 4 per cent sinking fund debentures due July 15, 1983 were placed on the market, the debentures are priced at 100½ per cent and accrued interest to yield approximately 3.97 per cent to maturity.

Δ Allegheny Ludlum Steel Corp. announced start of construction of a new metallurgical laboratory to its laboratory research center at Brackenridge.

Δ The Federal Reserve Board reported that the output of the nation's mines and factories increased to 130 per cent of the 1947–49 average which compares with 128 per cent in May, 1958 and 145 per cent in June 1957.

Δ The Commerce Dept. reported that personal income in June set a seasonally adjusted annual pace

of $351,800,000,000 almost $2,000,000,000 above May, 1957 and $6,700,000,000 higher than June, 1957.
Δ The Agriculture Dept. reported that farmers' net income rose to an annual rate of $13,300,000,000 in the first half of 1958 which was 22 per cent higher than the first half rate in 1957.
Δ The Commerce Dept. reported adjusted annual rate for corporate profits before taxes for the first quarter of 1958 at $31,700,000,000 which compares with $39,900,000,000 in the final quarter of 1957.

July 18

Δ The ARCI reports that deliveries of new domestic freight cars in June, 1958, totaled 2407 compared with 3534 in May, 1958, and 8377 in June, 1957. Orders totaled 317 compared with 1372 in May, 1958 and 4918 in June, 1957. Backlog of cars on order as of July 1, 1958 stood at 27,757 compared with 30,386 a month earlier and 91,810 on July 1, 1957.
Δ Acos Villares, S.A., of Sao Paulo, Brazil, one of Brazil's largest producers of special alloy steels signed a credit agreement with the Export-Import Bank for $1,700,000 to finance a program to boost output.
Δ Custom smelters increased their price for copper to 26½¢ a lb, up ½¢.

July 19

Δ The Commerce Dept. reported estimated exports in May totaled $1,664,000,000 in May, 1958 compared with $1,531,000,000 in April, 1958 and $1,813,000,000 in May, 1958.

July 21

Δ The AISI reports that the operating rate of the steel industry for the week of July 21 is scheduled at 1,540,000 tons (57.1 per cent of capacity). This compares with 1,481,000 tons one week ago (54.9 per cent capacity) and 2,033,000 tons one year ago. Index of production for the week is 95.9.

July 22

Δ Preliminary Treasury figures show that government expenditures in the fiscal year ended June 30 exceeded revenues by $2,800,000,000. In both 1956 and 1957 fiscal years a surplus was accumulated, and for the fiscal year which began July 1, 1958, a deficit above $10,000,000,000 is forecast.
Δ Continental Can Co. announced it would supply aluminum quart size cans for motor oil at prices comparable with tin plate containers.
Δ The International Nickel Co. Inc. announced a new price of its 75 per cent nickel oxide, packaged, of 69.6¢ per lb of contained nickel, f.o.b. Buffalo, N. Y. or other established points of entry into the U. S. Previously the price was 70.25¢, unpacked, f.o.b. Copper Cliff, Ontario. The International Nickel Co. of Canada, Ltd. simultaneously announced that its price for this product in Canada would be the Canadian dollar equivalent to the new price, delivered at customer's works.

July 23

Δ The President's Council of Economic Advisers reported that national production of goods and services rose to a rate of $428,000,000,000 annually in the quarter ended June 30, a $2,200,000,000 increase over the first quarter pace.
Δ The Aluminum Assn. reported primary aluminum production in the United States during June, 1958, was 115,325 short tons compared with 126,327 short tons in May, 1958, and 138,007 tons in June, 1957.

July 24

Δ Consumer prices rose 0.1 per cent in June to 123.7 per cent of the 1947–49 average.
Δ Allis-Chalmers reported sales for the first six months of 1958 amounting to $269,506,611, net profit of $8,399,788 or $1.02 per common share; for the same period in 1957 sales amounted to $285,831,554, net profit was $11,048,383 or $1.35 per share.

July 25

Δ The Administration is requesting Congress to increase the statutory limit on total Government obligations to $288,000,000,000; $3,000,000,000 of this would be temporary, and $285,000,000,000 a permanent debt limit compared to the present debt limit of $275,000,000,000.
Δ The Industrial Heating Equipment Assn. reports that new orders for industrial furnaces in June, 1958 were $3,672,000, compared with $953,000 in May, 1958. Total net new orders for the first half of 1958 amounted to $17,802,000, compared with $43,348,000 in the same period of 1957. Orders for induction and dielectric heating equipment in June, 1958, were $602,000 compared with $501,000 in May, 1958. Total net new orders for the first half of 1958 were $2,915,000, compared with $4,804,000 for the same period in 1957.
ΔAISC reports that bookings of fabricated steel in June, 1958 totaled 286,798 tons compared with 224,308 tons in May, 1958 and 247,152 tons in June, 1957; shipments in June, 1958 totaled 329,240 tons, compared with 328,180 tons in May, 1958 and 384,724 tons in June, 1957. In the first six months of 1958 bookings totaled 1,263,041 tons, shipments of 1,916,-910 tons compared with the same period of 1957 bookings of 1,915,439 tons, shipments 2,075,718 tons. Total backlog on June 30 was 2,190,943 tons.
Δ Shipments of iron and steel castings during May, 1958 amounted to 955,362 short tons compared with 948,879 tons in April, 1958 and 1,353,175 tons in May, 1957.

July 28

Δ The AISI reports that the operating rate of the steel industry for the week of July 28 is scheduled at 1,586,000 tons (58.8 per cent of capacity). This compares with 1,546,000 tons one week ago (57.3 per cent capacity) and 2,033,000 tons one year ago. Index of production for the week is 98.7.

July 29

Δ The Aluminum Assn. reported that shipments of aluminum sheet and plate in June, 1958, totaled 106,364,000 lb, compared with 102,903,000 lb in May, 1958; shipments of aluminum foil in June, 1958, totaled 14,587,071 lb, compared with 14,956,157 lb in May, 1958.
Δ The F. W. Dodge Corp. reports that construction contracts in the United States in June totaled over $3,800,000,000, 12 per cent higher than May, 1958 and 18 per cent higher than in June, 1957.
Δ The Bureau of Mines reported that production of Pennsylvania anthracite for 1957 totaled 25,338,321, compared with 28,900,220 in 1956; value at the preparation plant, 1957 equaled $227,753,802, compared with 1956 value of $236,785,062; average net realization per ton in 1957 amounted to $8.99 compared with $8.19 in 1956.

July 31

Δ Aluminum Co. of America announced an increase of 0.7¢ per lb in aluminum pig to 24.7¢.

△ Westinghouse Electric Corp. reports for the second quarter of 1958 sales amounting to $474,632,000, net income $17,070,000 or 97¢ a share; compared with the same period of 1957, sales $507,253,000, net income $16,417,000 or 95¢ a share. For the first half of 1958, sales amounted to $923,961,000, net income $29,973,000 or $1.70 a share, for the same period of 1957, sales were $982,939,000, net income $30,615,000 or $1.77 a share.

△ Spot copper prices in London advanced more than ¾¢ per lb, to 26¢ a lb.

△ The House approved a bill to increase social security benefits 7 per cent, a minimum of $3 a month, and from the present 2¼ per cent on the first $4200 the tax will be increased to 2½ per cent on the first $4800 effective January 1, 1959.

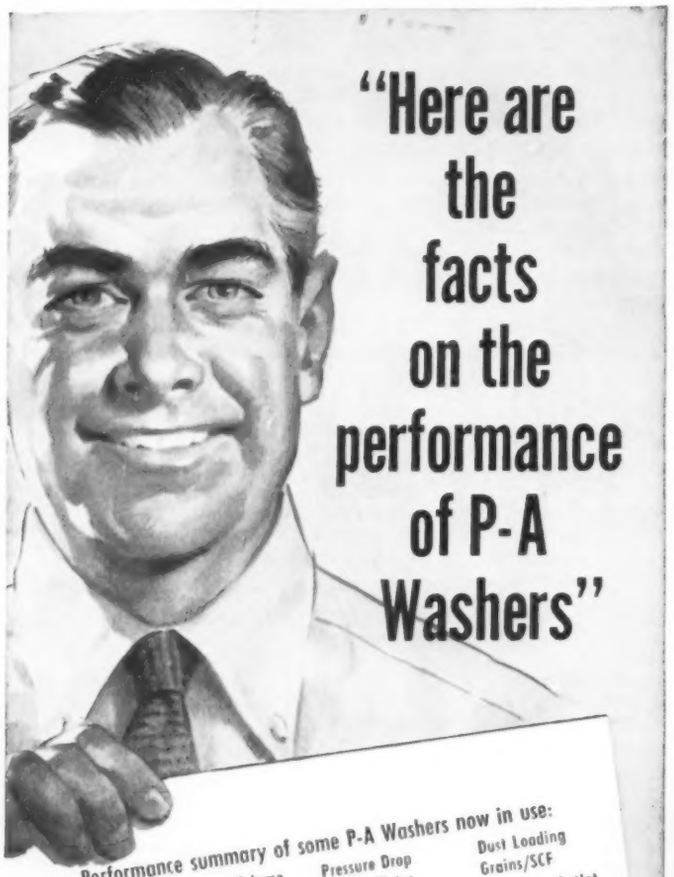
△ Steel scrap prices in Chicago advanced as much as $3 a ton, No. 1 heavy smelting railroad scrap were reported at $50 a ton; in Philadelphia, sales of No. 1 heavy melting steel scrap were reported at $37 a ton, up $2.

△ Armco Steel Corp. announced price increases on sheet and strip products. This was quickly followed by most of the other major producers, with new prices ranging from $3 to $7 higher a ton on various products.

STEEL COMPANIES QUARTERLY FINANCIAL REPORTS—ENDING JUNE 30, 1958

	Period	1958 Net sales	1958 Net profit	1958 Earnings per share	1957 Net sales	1957 Net profit	1957 Earnings per share
Acme Steel Co.	2nd quar.	$ 29,364,156	$ 1,137,369	$ 0.41	$ 38,415,142	$ 1,707,322	$0.69
	1st half	57,900,118	1,577,196	0.57	82,629,081	3,941,773	1.62
Alan Wood Steel Co.	2nd quar.	12,604,000	306,000	0.35	17,837,000	537,000	0.69
	1st half	25,210,000	339,000	0.31	36,366,000	1,436,000	1.89
Allegheny Ludlum Steel Corp.	2nd quar.	48,780,365	646,067	0.17	72,415,439	2,951,427	0.77
	1st half	99,235,290	1,371,967	0.36	153,710,065	7,742,092	2.01
Armco Steel Corp.	2nd quar.	219,474,943	11,626,179	0.79	287,101,595	19,196,755	1.33
	1st half	415,489,743	20,956,744	1.42	564,220,817	38,583,106	2.66
Barium Steel Corp.	1st half	15,150,355	(1,060,431) (loss)	(1.02)	Not comparable		
Bethlehem Steel Corp.	2nd quar.	506,049,384	29,003,419	0.61	687,226,813	50,273,507	1.09
	1st half	1,003,607,711	53,822,909	1.13	1,363,334,801	103,701,162	2.25
A. M. Byers Co.	2nd quar.	6,887,187	280,050	0.79	6,870,629	39,950 (before preferred div.)	(0.13) (loss)
Colorado Fuel & Iron Corp.	2nd quar.		1,063,388	0.27		4,352,322	1.24
	1st half		(326,708)	(0.17)		8,904,714	2.55
Continental Steel Corp.	2nd quar.	14,172,777	1,088,915	2.11	13,294,271	1,024,048	1.98
	1st half	23,428,625	1,669,754	3.23	24,416,230	1,686,310	3.26
Copperweld Steel Co.	2nd quar.	19,616,658	(94,633)	...	33,284,292	1,000,987	0.87
	1st half	40,433,967	(207,138)	...	67,986,565	1,989,981	1.76
Crucible Steel Co. of America.	2nd quar.	41,255,709	226,932	0.06	65,705,550	2,673,390	0.73
	1st half	85,865,769	399,327	0.11	136,304,345	6,045,996	1.66
Detroit Steel Corp.	2nd quar.	13,686,073	(58,161)	(0.02)	24,116,626	788,298	0.26
	1st half	26,898,280	(301,839)	(0.14)	48,769,684	1,863,964	0.57
Eastern Stainless Steel Corp.	2nd quar.	11,957,794	684,226	0.95	13,767,469	940,669	1.31
	1st half	21,686,049	933,227	1.30	27,808,638	1,602,090	2.23
Firth Sterling, Inc.	2nd quar.	3,261,900	(271,500)	...	8,826,200	414,400	0.31
	1st half	6,924,100	(553,100)	...	17,336,700	812,400	0.61
Granite City Steel Corp.	2nd quar.	28,543,003	1,841,401	0.86	32,292,379	2,828,505	1.32
	1st half	57,445,712	3,896,583	1.81	65,988,260	6,249,956	2.92
Inland Steel Co.	2nd quar.	159,904,283	12,118,584	2.12	201,131,202	15,150,752	2.68
	1st half	310,181,569	20,079,731	3.51	406,780,842	29,764,456	5.26
Interlake Iron Corp.	1st half	37,542,527	1,245,190	0.56	58,137,996	3,634,648	1.62
Jessop Steel Co.	2nd quar.	8,819,377	274,206	0.48	14,489,723	875,908	1.63
Jones & Laughlin Steel Corp.	2nd quar.	156,215,000	4,034,000	0.47	228,393,000	13,770,000	1.85
	1st half	300,799,000	5,691,000	0.64	432,358,000	26,593,000	3.58
Kaiser Steel Corp.	2nd quar.	47,019,809	2,235,711	0.47		7,124,369	2.02
	1st half	93,313,054	3,970,137	0.83	111,891,445	14,908,487	4.24
Keystone Steel & Wire Co.	Fiscal Year		5,984,595	3.19		8,476,095	4.52
Lone Star Steel Co.	1st half	23,359,657	482,829	0.15	51,551,186	6,664,060	2.09
Lukens Steel Co.	24 wks. ending June 14	51,349,178	3,057,009	3.20	61,687,469	5,979,164	6.27
McLouth Steel Corp.	2nd quar.		1,862,800	0.97		1,937,782	1.09
	1st half		2,316,837	1.00		5,369,595	3.18
National Steel Corp.	2nd quar.	117,799,412	6,527,762	0.88	166,490,249	12,607,341	1.70
	1st half	231,288,194	10,329,188	1.39	343,348,458	26,108,847	3.52
Pittsburgh Coke & Chemical Co.	2nd quar.	11,276,000	233,000	0.11	13,347,000	744,000	0.55
	1st half	21,541,000	443,000	0.20	27,028,000	1,652,000	1.25
Pittsbugh Steel Co.	2nd quar.	30,914,651	(563,778)	(0.56)	47,489,480	1,610,063	0.81
	1st half	63,027,163	(1,532,659)	(1.38)	97,276,419	3,621,323	1.87
Republic Steel Corp.	2nd quar.	228,433,654	15,321,096	0.98	339,515,410	24,865,071	1.60
	1st half	422,277,491	23,904,602	1.53	695,212,075	52,917,897	3.40
Sharon Steel Corp.	2nd quar.	30,820,505	(735,721)	...	37,829,217	1,137,381	1.03
	1st half	44,722,314	(1,018,934)	...	85,495,006	2,730,025	2.48
United States Steel Corp.	2nd quar.	863,067,790	73,224,051	1.25	1,170,314,575	115,943,199	2.04
	1st half	1,663,141,814	135,650,730	2.29	2,336,798,663	231,421,308	4.07
Washington Steel Corp.	2nd quar.		336,173	0.55		381,300	0.62
	9 mos.		246,668	0.36		1,464,847	2.40
Wheeling Steel Corp.	2nd quar.	57,152,000	2,464,000	1.05	68,534,000	2,834,000	1.24
	1st half	103,677,000	2,969,000	1.08	140,281,000	7,393,000	3.36
Youngstown Sheet and Tube Co.	2nd quar.	124,183,526	4,236,641	1.23	179,291,257	11,317,042	3.29
	1st half	239,522,497	7,812,741	2.27	371,367,128	21,924,309	6.38

Numbers in parentheses indicate losses.



"Here are the facts on the performance of P-A Washers"

Performance summary of some P-A Washers now in use:

Installation	Years Operated	Volume SCFM	Pressure Drop Inches Water	Dust Loading Grains/SCF Inlet	Outlet
A	4	78,000	30	3-19.0	.01-.04
B	3½	78,000	30	2-3	.02-.08
C	3	85,000	30-40	2-3	.01-.03
D	3	45,000	30	2	.02-.03
E	½	75,000	50	—	.02
F*	½	26,000	12	5	.10
G*	½	26,000	12	5	.10
H	½	90,000	29	—	.04

*Two units in parallel on one furnace. Lower efficiency due to lower available top pressure

These actual performance figures reflect the highly efficient operation of the Pease-Anthony washer. This venturi scrubber puts your full top pressure to work cleaning the gas. No secondary cleaner required for most installations. Present users report no maintenance problems. If you have a blast furnace scheduled for construction or rebuilding, plan now for P-A Venturi installation. Capacities up to 150,000 SCFM. Write for bulletin M-103.

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P-A GAS SCRUBBERS

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We offer forty years of experience in producing the highest quality Metal Cutting Knives and skilled craftsmen working with the finest materials to exacting tolerances.

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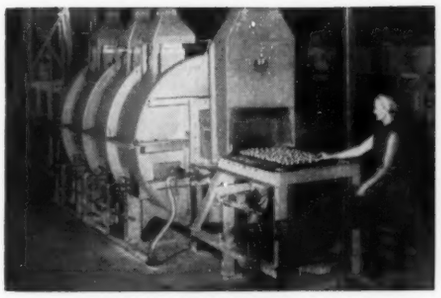
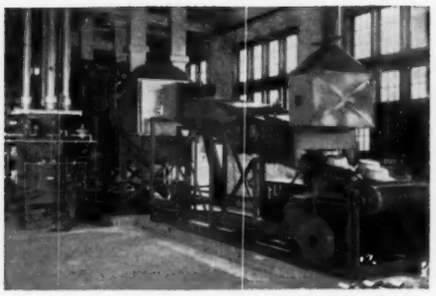
SEND Today for information on GEM'S line of refractory insulating brick and materials.

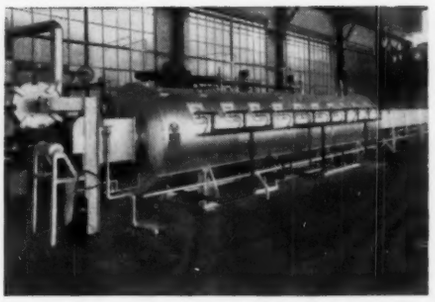
Leaders in Engineered Refractories for more than 50 years



EF gas fired muffle type continuous furnace, one of several types we build for sintering non-ferrous and iron powder products.



This type bright anneals stainless steel stampings, flatware, drawn and other products—economically, uniformly and continuously.



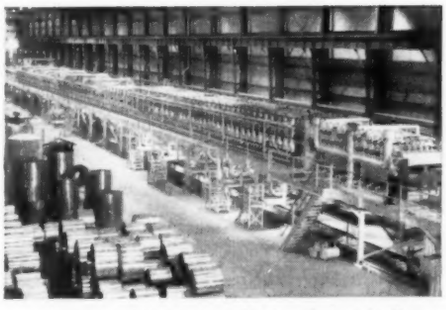
Another type we build for bright annealing stainless steel. This EF furnace also handles other grades requiring lower temperatures.

If **YOU** *Want*

1. Modern Proven Design
2. Latest Technological Improvements
3. High Hourly Output
4. High Heating Efficiency
5. Dependable Automatic Operation
6. Skillful Fabrication and Installation

you need an EF PRODUCTION FURNACE

we build any size or type for any production requirement



A large combination gas fired and electrically heated continuous galvanizing furnace installation (over 300 feet long). As usual this equipment was completed and in production on schedule, and the first coil run through was accepted as first class salable material.

EF production furnaces assure users utmost uniformity, efficiency, economy, and maximum return per dollar invested. Our complete line of continuous and batch furnaces — gas fired, oil fired or electrically heated — enables us to recommend, without bias, the size, type and fuel that will meet your particular problem best. Furnished complete with special atmosphere equipment and materials handling facilities. Let us work with you on your next annealing, normalizing, coating or other heat processing project. You'll find . . .

it pays to submit your production furnace problems to experienced EF engineers.

THE ELECTRIC FURNACE CO.

GAS FIRED, OIL FIRED AND ELECTRIC FURNACES FOR ANY PROCESS, PRODUCT OR PRODUCTION

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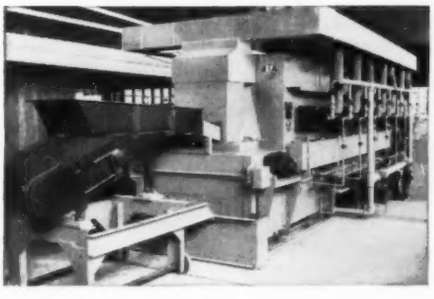
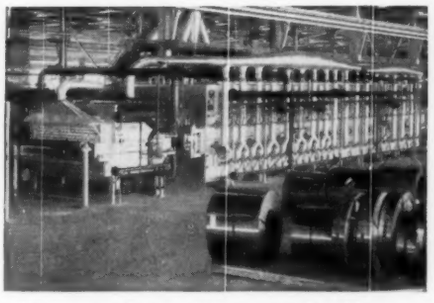
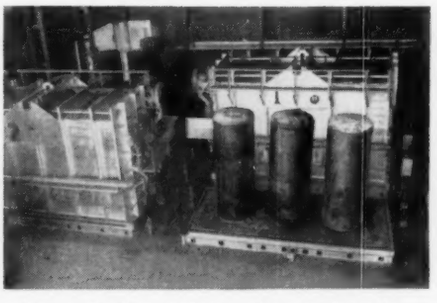


EF gas fired radiant tube combination hardening and dry cyaniding unit fitted with an automatic feeder that distributes the parts evenly on the chain belt conveyor; and a dual quench.



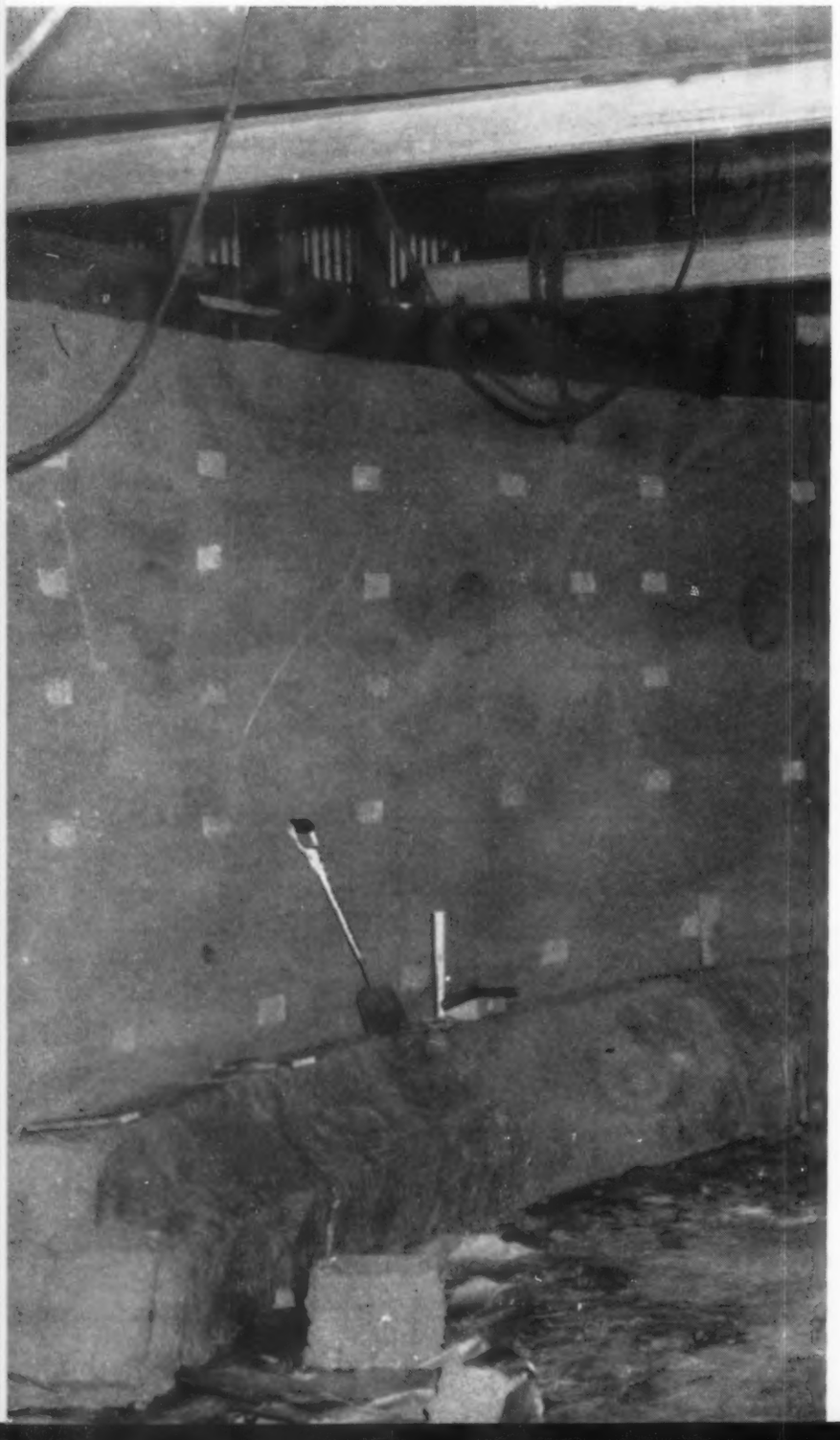
EF gas fired unit—bright anneals wide or narrow strip in single or multiple strands. Other continuous and batch types for ferrous or non-ferrous including stainless.



EF gas fired special atmosphere rectangular bell type strip annealers with individually controlled forced circulation 3-stack bases each with capacity of 135,000 lbs. per charge.

Ramtite®

Past Performance Got the Order——



The order to line the inner and outer walls, sub-hearth and hearth rim of this 55 ft. rotary hearth furnace was based on past performance—cost reducing Ramtite performance in existing furnaces at this mill. The furnace was designed and built by Salem-Brosius, Inc., and the installation was made in August, 1956.

The walls were lined with Special Super Ramtite No. 25 securely tied back to the steel structure with Ramtite Safe-Tie Refractory Anchors.

Ramtite WASP No. 30 was used in place of rim tiles to line both the inner and outer hearth rims.

A sub-hearth of LWC light weight castable 5″ thick, topped with Fracto-Crete No. 62 refractory castable 5″ thick was installed between the hearth rims.

Ramtite is our business . . .

Present Performance Proves It

Now, after more than a year and a half of top service, the Ramtite installation still looks extremely good.

The Ramtite wall construction and inherent spall resistance have prevented any wall bulging or spalling.

The difficulties often encountered with rim tile have been eliminated. Ramtite WASP No. 30 will not spall or work loose, move out and jam into the sides of the furnace.

And, a brick curtain wall installed when the furnace was built, has since been replaced with Ramtite at the customer's request and to his satisfaction.

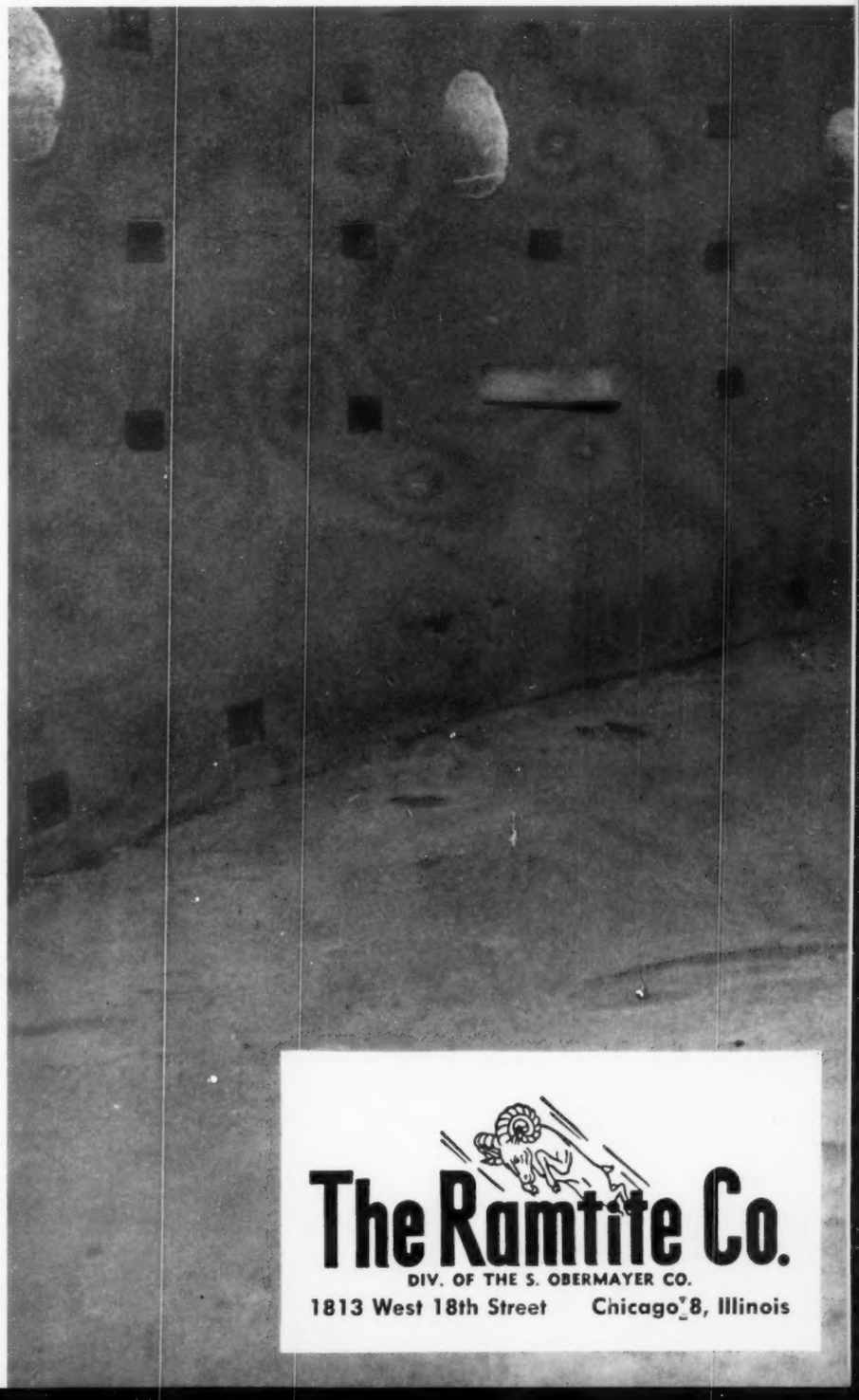
Ramtite past performance got the order!

Ramtite present performance proves it!

The Ramtite Co. offers you a complete sales engineering service. Experienced men are always available to study your refractory problems and consult with your Engineering, Mason and Ceramic Departments about your specific needs.

Write us today for further information.

Not a side line!



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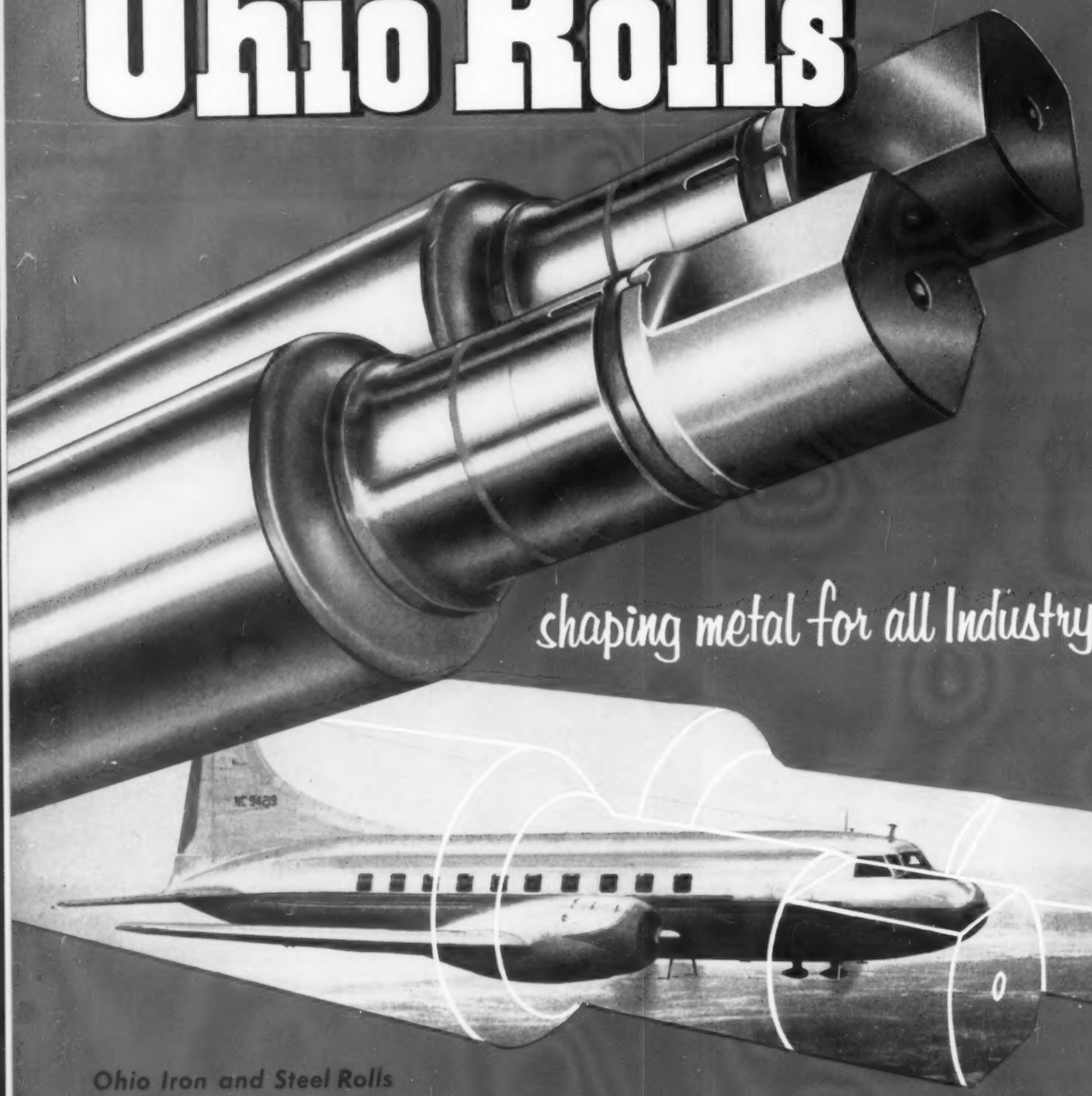

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Industry News...

KAISER STEEL ANNOUNCES COMPLETION OF NEW 86-IN. HOT STRIP MILL AT FONTANA

△ Completion of the new 86-in. hot strip mill, the largest steel finishing mill at Kaiser Steel Corp.'s Fontana, Calif., plant, was announced by Jack L. Ashby vice president and general manager.

The installation includes three preheat furnaces, a scale breaker, and 11 roughing and finishing rolling stands arranged in tandem.

The hot strip mill formerly was dependent on the plate mill for partially rolled slabs, and the new mill makes more rolling time available for plate production, Mr. Ashby explained.

New equipment—including the three furnaces, the scale breaker, a 136-in. broadside mill to widen slabs, and four 89-in. mills to lengthen slabs—has been integrated with the plant's existing six-stand, 86-in. finishing mill, which was relocated in the new building from its previous location in the plate mill.

The mill is designed to convert a typical six-ton steel slab (4 in. by 40 in. by 22 ft) into a coiled tin mill hot band 1/16 in. thick, 40 in. wide, and more than a quarter of a mile long—in approximately two minutes. The new mill can handle slabs measuring up to 6 ft wide and 22 ft long and weighing over 16 tons.

Kaiser Engineers Division of Henry J. Kaiser Co. is designer and prime contractor for the entire $214,000,000 expansion program, which will be completed by the end of 1958. Still under construction are three basic oxygen furnaces, a fourth blast furnace, ninety coke ovens a slabbing mill, and enlarging of the plate mill.

The expansion will virtually double Kaiser Steel's capacity from 1,536,000 ingot tons per year to 2,933,000 ingot tons per year.

The huge, new 86-in. hot strip mill at Kaiser Steel's Fontana plant is housed in a half-mile long building which covers more than eight acres. In two minutes a steel slab travels from the furnaces at one end of the building, through five new rough rolling stands and six finishing stands (pictured) to the coiler at the far end—a distance of 1245 ft.

WEIRTON OPERATING NEW SINTERING PLANT

△ A sintering plant, capable of producing more than 6000 tons per day, has been placed in operation at Weirton Steel Co. division of National Steel Corp., it was announced by C. J. Klein, vice president of Engineering for National Steel.

Mr. Klein stated that while the Weirton unit, with a sintering machine 12 ft wide and 147 ft long, is presently the world's largest, a larger plant is nearing completion at Great Lakes Steel Corp. in Detroit—and will be placed in operation about August 1. This plant will have a sintering machine 12 ft wide and 153 ft long.

The new plant at Weirton, which can produce 3½ tons per sq ft of hearth, was built by Koppers Co., Inc. and incorporates the newest features including a radiant type furnace for firing the mix. Most other plants use a direct firing method.

There are 14 double windboxes with two sintering machine fans to draw the heated air from the furnace down through the sinter bed and ignite the mix. The fans have a total volume of 512,000 cfm at 350 F, and each is driven by a 3500 hp motor.

The mixed material, spread evenly on the moving bed, is initially fired by the radiant type furnace and from there on the coke in the mixture is fired by the air being drawn down through the bed. By the time the mixture reaches the end of the bed, the coke has been consumed and a hot mass of sinter is formed. As the pallets turn at the end of the bed the hot sinter mass drops off.

The sinter goes to a pallet type air sinter cooler 10 ft wide by 147 ft long. This unit, designed to cool the sinter to a temperature below 200 F, has 14 windboxes and two fans, each rated at 258,000 cfm and driven by a 450 hp motor.

After the cooling process, the sinter is conveyed by belt to storage hoppers and then by transfer car to the blast furnaces.

The discharge end of the machine is equipped with a centrifugal dust collecting unit rated at 60,000 cfm, the hot sinter screens have a similar

unit rated at 75,000 cfm and another unit at the cold sinter screen is rated at 10,000 cfm.

Water from the dust collectors is piped to Dorr thickeners where the dust is removed as a sludge by sedimentation. The sludge goes to fabric filters where filter cake is produced, and clear water is discharged from the Dorr thickeners.

In the operation of the new sinter plant, iron ore first passes through a wobbler which separates that which is two inches and under in size, with the ore that doesn't meet this size requirement being returned to the ore yard.

The ore two inches and under next goes through a crusher and screens where it is prepared to a 3/8 in. size, then is moved to storage bins. The sinter plant has a total of 14 storage bins, ranging up to 600 tons capacity per bin, which are used to store the iron ore, coke breeze, coke dust, limestone, flue dust and cold sinter fines, all of which are used to charge the sinter machine.

These various materials are processed for mixing and moisture control, first through a primary pug mill that is 11 ft in diam and 14 ft 6 in. long, and then through a secondary balling drum that is 12 ft in diam and 40 ft long. The mixed material is then conveyed by a roll-type feeder onto the sintering machine which is made up of a series of pallets placed end to end and traveling on an endless track.

BUILDING PILOT PLANT FOR COAL PREPARATION

△ Full-scale experiments in preparing and blending coal for coke ovens and measuring the recovery of gas and coal chemicals will begin shortly at United States Steel Corp.'s Clairton Works with the building of a pilot plant, F. A. Dudderar, general superintendent, has announced.

Mr. Dudderar pointed out that with the modern pilot plant it will be possible to carry on important coal preparation, coke and coal chemical research on a large scale for the first time in this country. It is also to be expected, he continued, that utilizing the modern pilot plant facilities, improved techniques in coal preparation and the use of coke and coal chemicals could be anticipated.

To be housed in a building now under construction, the coal preparation pilot plant will be equipped to operate at a maximum rate of 50 tons per hr. Raw coals will be received by rail or truck, prepared, and conveyed to a 100-ton bunker which serves the experimental ovens.

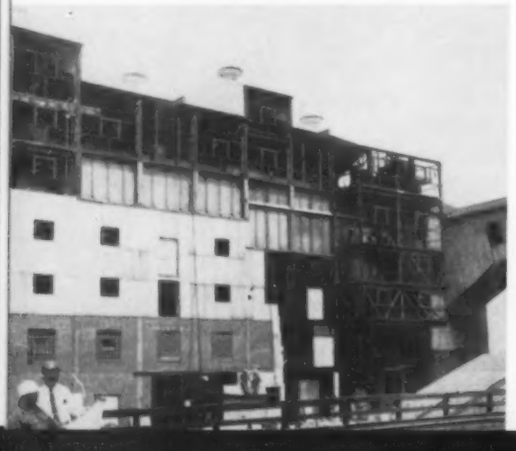
Coal preparation will include any combination of operations such as crushing, pulverization, drying bulk-density control, mixing and blending of various coals, as well as possible admixtures of a variety of inert materials with coal. Possible areas of exploration will be the effect of various coal preparation steps on coke strength, coking time, furnace coke yield, coal chemical yields and process loss with regard to a given coal or blend of coals.

After special preparation of the coal, the results of the coking process will be analyzed through the use of five commerical size coke ovens at the No. 12 battery. The primary function of these ovens will be to process the entire charge of each test oven during its coking cycle in order to measure the recovery of gas, tar and liquor. In addition, approximately 10 per cent of the total gas will be withdrawn throughout the coking cycle for recovery of ammonia, naphthalene and light oil.

The experimental ovens can be used interchangeably as integral ovens of No. 12 battery, or any one of the five as a separate experimental oven. The volatile matter evolved from the experimental ovens can be discharged directly into the regular battery collector main or into the small collector main serving the coal chemical pilot plant.

The experimental gas collecting system will be equipped with an in-

Checking on the construction of the coal preparation building are (left to right) Joe Fear, erection superintendent, Hewitt & Robins, Inc., and Robert Walls, research chemist, Clairton Works, U. S. Steel Corp.



How to measure

Now is the time to take a long, hard look

A continuous furnace is more than just a brick-lined structure built to heat a material; it is a processing tool.

Like all processing tools, it must be evaluated on an overall basis. Fuel consumption and efficiency may be completely outweighed by many more-important economic factors centering around your workpiece, your total production program, and your work force.

Your evaluation may well prove that an investment now in Selas continuous heat processing will bring immediate returns in reduced costs and improved product quality.

To help you take this long, hard look at your heat processing equipment or requirements, Selas offers these 15 evaluation factors:

- **Work in process**
- **Material handling**
- **Product value**
- **Product quality**
- **Production requirements**
- **Process coordination**
- **Automatic operation**
- **Temperature control**
- **Labor requirements**
- **Fuel efficiency**
- **Maintenance**
- **Equipment flexibility**
- **Material saving**
- **Human element**
- **Floor space**

The factual report on the facing page tells how a steel mill took this long, hard look at its heat treating operations. All evaluation factors proved important: several represented significant savings!

SELAS

the real cost of automatic heat processing

. . . here's how one SELAS installation stands up under that "long, hard look!"

High speed heating furnaces, designed to meet the demands of high speed production, have become an improved processing tool for the steel industry.

Heating die blocks for hardening is no longer a 20-30 hour operation at this steel mill.

A completely automatic program-control heating method designed and built by Selas increases heating rates 5 times, reduces the cycle to 3-4 hours for work loads up to 20 tons.

The installation is the outgrowth of a search for a heating method that would enable the mill to keep pace with increasing production requirements without undergoing costly plant expansion.

The entire furnace was prefabricated at Selas and, within one week of delivery, production tests were under way.

Work in Process

The one Selas furnace handles as much tonnage as 5 conventional furnaces of same size. For a given rate of output, work in process in Selas furnace is ⅕ that required by conventional heating.

Material Handling

The ability to process increased tonnage in shorter time in one furnace contributes to more efficient use of handling equipment.

Product Value

Value of material processed in only six turns exceeds the cost of the furnace!

Product Quality

This furnace successfully treats large sections of hard-to-harden steels. A typical analysis is 0.50 carbon, 0.70 manganese, 0.04 phosphorus, 0.04 sulphur, 0.25 silicon, 0.85 chromium, 0.04 molybdenum and 0.06 vanadium.

Production Requirements

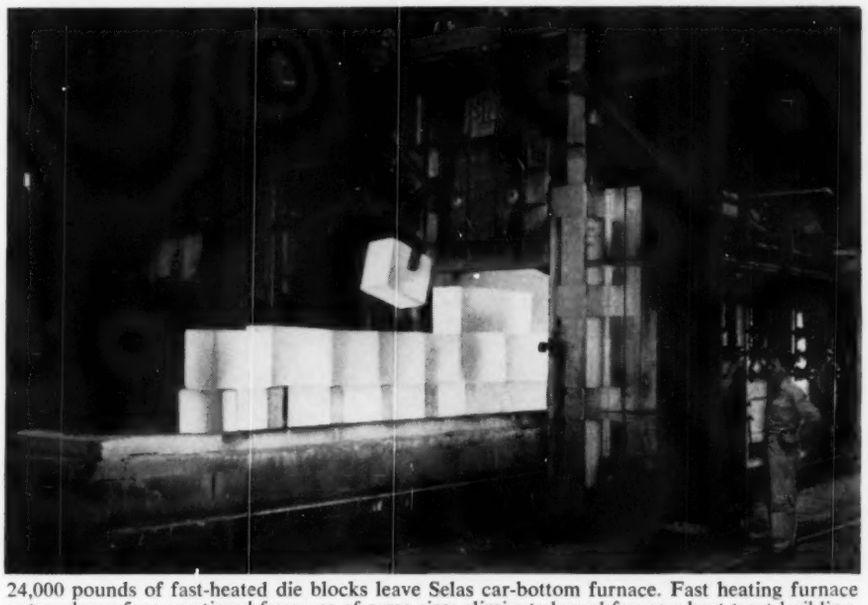
The Selas furnace meets increasing production demands for die block hardening without expanding plant facilities. This fast heating furnace has become primary source of die block heating with twelve other conventional furnaces being used to supplement production needs.

Process Coordination

The Selas furnace makes possible close adherence to a tight production schedule resulting in overall plant efficiency. Manpower, crane and quench facilities are effectively utilized.

Automatic Operation

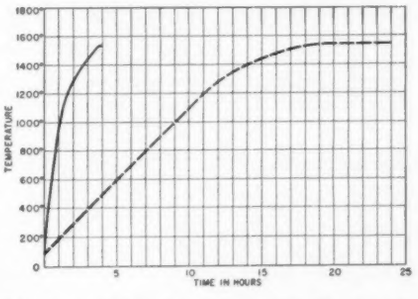
Fast response of this Gradiation® furnace permits accurate automatic control of die block temperature. Cams set temperature cycle to meet heat requirements in terms of thickness of die blocks.



24,000 pounds of fast-heated die blocks leave Selas car-bottom furnace. Fast heating furnace outproduces 5 conventional furnaces of same size; eliminated need for new heat treat building.

Temperature Control

Heating is completely automatic, the temperature being regulated by preset program-control. Uniform heating by radiant gas fired Duradiant® burners permits drastic reduction of heating cycle. Curves compare heating rates for center of die



block in Selas furnace (solid line) with conventional long heating cycle (dashed line). Temperature readings in °F.

Labor Requirements

Process requires minimum attention. About 20 min of an operator's time is all that is needed over an entire heating cycle.

Fuel Efficiency

Total fuel cost, something under $2.00 per ton, is actually 1/60 of the product value of a single furnace charge. Furnace uses 20% less fuel per ton of steel heated than conventional furnaces.

Maintenance

Practically none in 4 years.

Equipment Flexibility

Blocks processed in this furnace range from 8 in. to 24 in. thick. Designed for 20-ton charge, furnace has processed charges weighing from 6 to 28 tons.

Material Saving

High yield is maintained on a continuing basis; scale formation is negligible.

Human Element

Automatic control of the heating cycle eliminates variations due to human handling and operation.

Floor Space

In the space previously occupied by one conventional furnace, this Selas fast heating furnace now accomplishes the work of 5 conventional furnaces! Eliminated need for new heat treat building.

* * *

For case histories covering steel mill heat processing operations, as well as heat treating, heating for hot working and brazing, send for reprint "An Economic Appraisal of Continuous Heat Processing" and "Fast Heating Is Practical . . . and Safe." Address Dept. 48, Selas Corporation of America, Dresher, Pa.

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SELAS *Heat and Fluid Processing Engineers*
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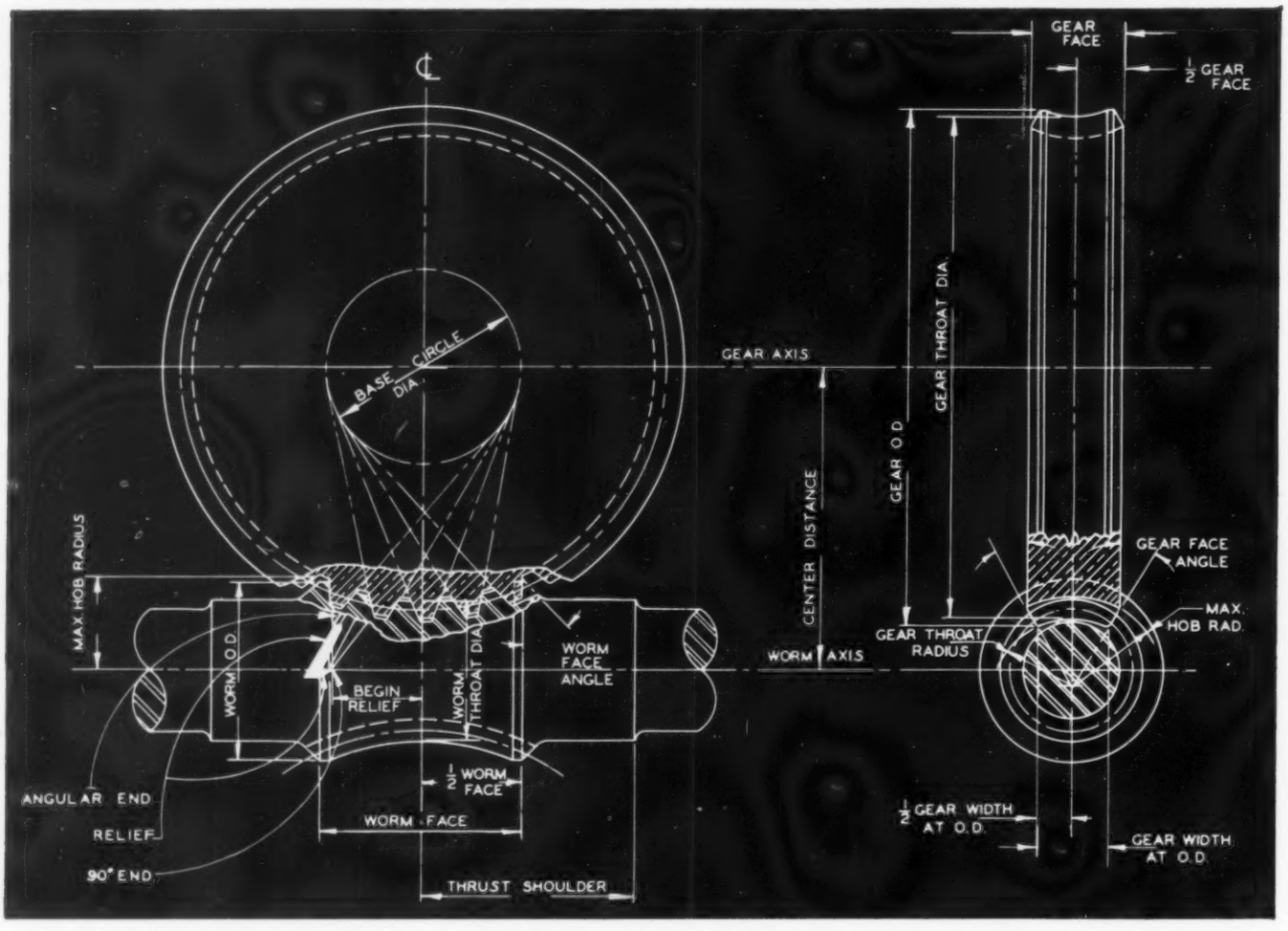
DEVELOPMENT • DESIGN • CONSTRUCTION

WORM GEAR DESIGN . . . *Bulletin #200*



Bulletin 200 has 20 pages crammed with 38 formulae, such as the Formula for Class I AGMA Horsepower Rating:

$$P = K_s K_m K_v \frac{n}{mg}$$

Step-by-step instructions, with typical examples, enable you to quickly determine the size worm gearset you need to meet any horsepower and service required.

You can calculate the bearing loads and sizes needed for the worm and gear shafts.

You can check the worm root stress and gear tooth stress.

Efficiency is charted against helix angle with modifications for required speed so you can quickly determine efficiency.

One quick look at the drawing above will convince even the uninitiated that no other worm gearset has so many teeth in contact. No other worm gearset is so simple to design and rate. No other worm gearset will carry so much load in so little space with so little weight.

Now, Bulletin 200 provides complete design and application data on space-saving double-enveloping worm gearing. Ask for it without obligation.

CONE-DRIVE GEARS DIVISION MICHIGAN TOOL COMPANY

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DOUBLE-ENVELOPING WORM GEARSETS | DOUBLE-ENVELOPING WORM GEAR SPEED REDUCERS | DOUBLE REDUCTION WORM GEAR SPEED REDUCERS | DOUBLE-ENVELOPING RIGHT ANGLE GEARMOTORS

dependent flushing liquor system, which will be tied in with the regular battery flushing liquor system.

TIN PLATE EXPANSION ANNOUNCED BY INLAND

△ Inland Steel has announced a new expansion move which will step up its tin-plate production capacity by more than 60 per cent, enable it to treat two-thirds of all its tin mill products by continuous annealing and to deliver the metal in coils to can manufacturers who use it in that form.

Joseph L. Block, President, in telling of the plan, said that the company expected the rapid growth in the use of tin-coated steel for cans to continue and that by this move is preparing to meet the anticipated demand and to supply the tin plate in the forms and types the can makers require.

No estimate of the separate cost of the tin mill project was announced. It was explained that it will make use of existing auxiliary equipment and include new coil handling equipment in the hot and cold strip mills that will also be used for products other than tin plate.

It was stated, however, that the total of unexpended appropriations for capital projects was now $125,000,000 including the tin mill program and related steps.

The company has already completed major phases of a three-year $280,000,000 expansion program and expects to have total capital outlays of approximately $100,000,000 this year, second in amount only to the $130,000,000 expended in 1957.

Work is expected to start on the tin mill expansion immediately with completion scheduled in 1960.

Among major items of the project are:

1. An electrolytic tinning line of 165,000 tons annual capacity that can turn out tin plate in coil form or sheared to length up to 46 in. It will bring the company's total capacity to 435,000 tons of tin plate annually.

2. A continuous annealing line of 165,000 tons annual capacity, making the company's new capacity 300,000 tons a year.

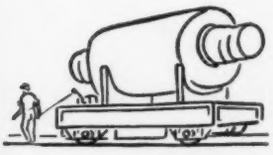
3. A new temper mill for restoring uniform temper to steel after annealing, with an annual capacity of 350,000 tons.

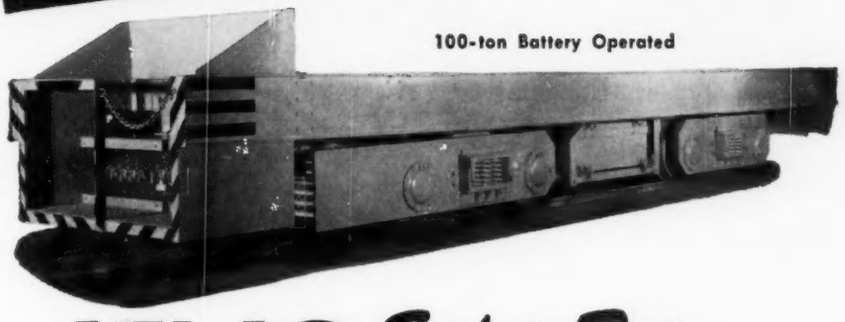
4. New coiling equipment for one of the company's continuous hot strip mills and new coil handling equipment for a cold strip mill.

HEAVY INGOT

This 66-ton steel ingot, the largest ever poured at Lukens Steel Co., is the first to be heated in new soaking pits just entering operation at Coatesville, Pa. The handling crane shown is capable of handling ingots weighing up to 75 tons each. Both the nine new pits and the handling crane are the first major facilities to be completed in Lukens' current $33,000,000 expansion program.

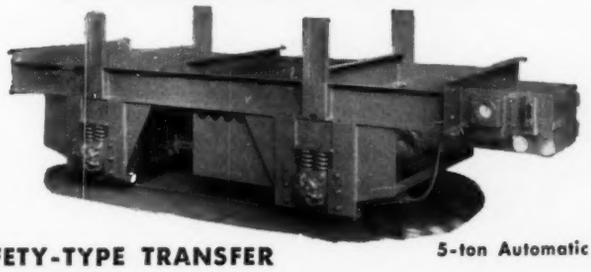
HANDLES THE BIG LOADS WITH BIG SAVINGS





100-ton Battery Operated

ATLAS *Safety Type* TRANSFERS



5-ton Automatic Controlled

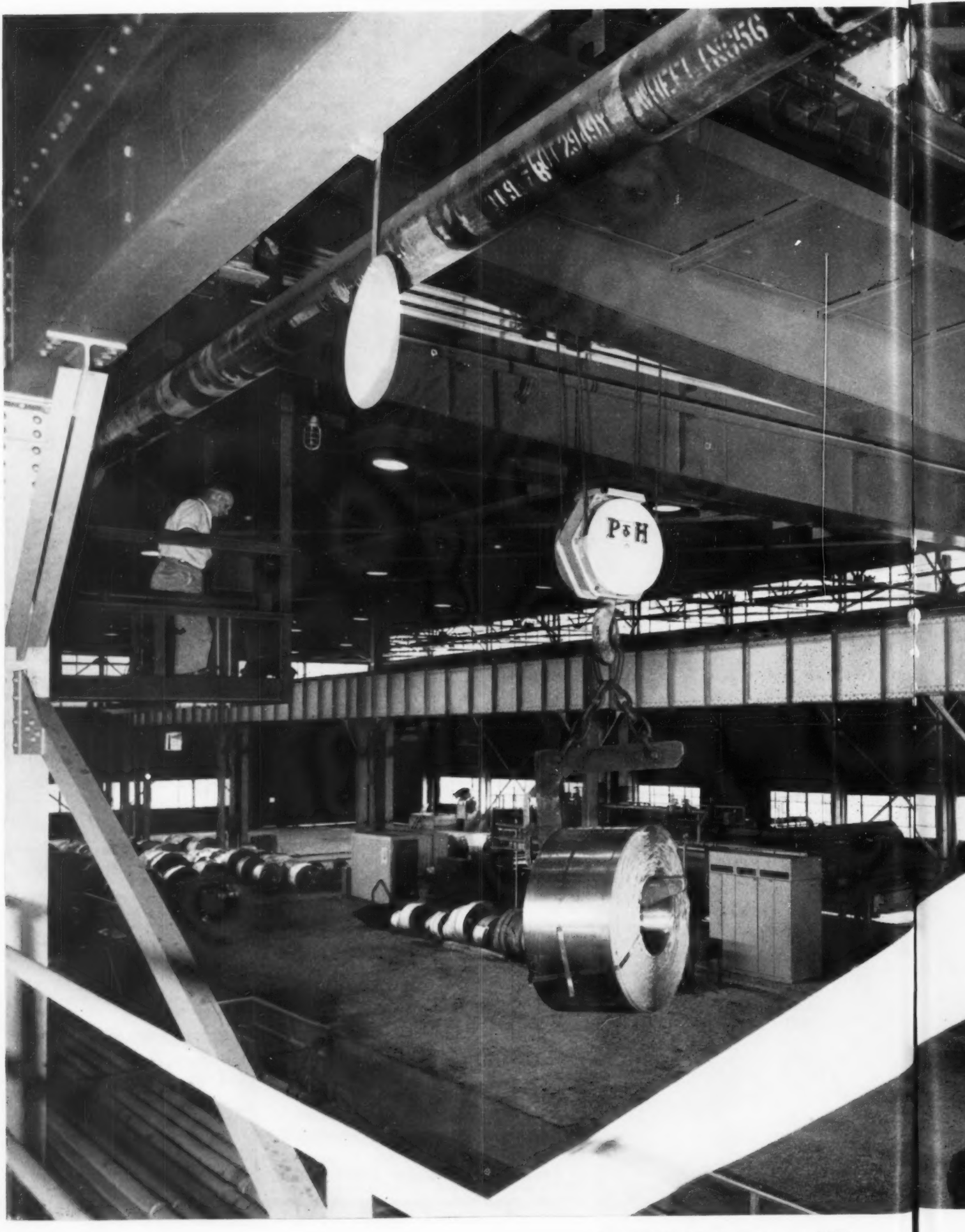
ATLAS SAFETY-TYPE TRANSFER CARS can be provided in almost any capacity for storage battery, diesel or gas-electric, or cable reel service.

They are safe because there is only one control lever, and the car moves only when the operator holds the lever.

Request "Walk-Along" Bulletin 1283.

ATLAS CAR & MFG. CO.
1100 IVANHOE ROAD
CLEVELAND 10, OHIO

ENGINEERS AND MANUFACTURERS SINCE 1896


P&H

Here is why it costs less to move steel with P&H mill cranes

1 P&H builds mill cranes to withstand the toughest duty cycles in steel-mill service. Trolleys and girders are husky all-welded steel units, trucks are MCB design with heat treated wheels, gears and shafts are alloy steel, and—most important — motors and control gear are ruggedly built specifically for crane service.

2 P&H maintains continuous research to improve crane efficiency and to guard cranes against obsolescence. Their latest development, P&H Electronic "Stepless" Crane Control, permits faster, safer handling and precise spotting of giant loads—greatly reduces crane maintenance.

3 P&H's broad experience in over 23,000 installations offers a wide choice in providing the *right* crane for every job, whether it's hook-type, grab-bucket, or magnet service.

4 Remember, too — only P&H offers you "one-source" responsibility for the design, manufacture, and service of *both* electrical and mechanical crane components.

For a new overhead crane, or to modernize your existing equipment, consult P&H first. Write Dept. 109G, Harnischfeger Corp., Milwaukee 46, Wisconsin.

P&H HARNISCHFEGER
...quality and service for 74 years

TRANTINYL

GUIDES THE STEEL INDUSTRY

Mill Guides

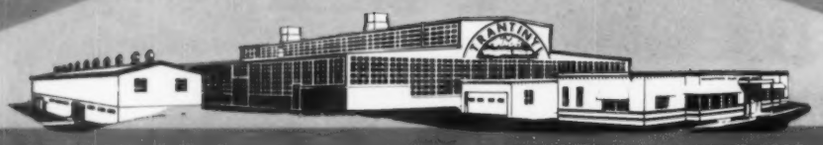
used by J&L STEEL

in new 44" strip mill at Aliquippa Works

"TRANTINYL" Service to Leading Steel Companies ... continuous for a quarter-century

Youngstown Alloy Casting Corporation
Youngstown, Ohio

Guides for Rolling Mills • Tube Mills • Straightening Machine Guides



G-15

Sole Licensee to cast "TRANTINYL" for the Midwest, West and South: WAUNAKEE ALLOY CASTING CORP., Waunakee, Wis.

News and Notes on...
Good Packing Practice

JOHNS-MANVILLE JM PRODUCTS

Maintenance and Design Hints from Johns-Manville Packings and Textiles Dept.

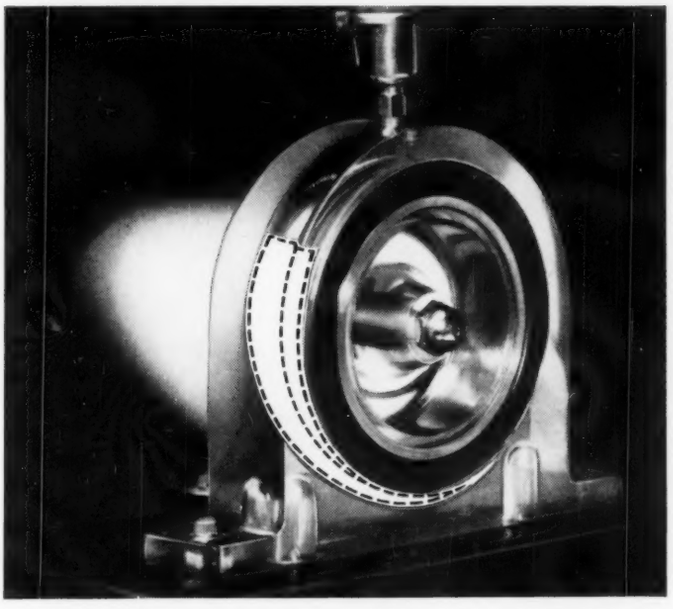
Subject of the month: Effective Shaft Sealing

Question: What is an economical way to seal in or seal out with maximum efficiency?

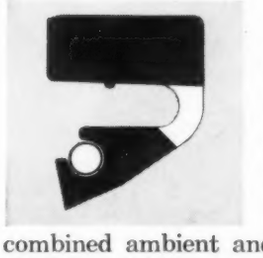
Whether the shaft bearing is of the sleeve, roller, or ball type . . . seals should meet two basic requirements: (1) provide a tight seal despite light applied pressure, and (2) resist abrasion and corrosion.

The transparent unit shown at the right was created by research engineers to study this subject of effective sealing . . . witness the performance of J-M seals in development stages. It helped them perfect the versatile, dependable line of J-M Clipper® Seals that serve many industries.

In this unit, Clipper Seals are mounted on a transparent cylinder, just as in a bearing cavity. The heel of the seal provides the rigidity essential for a press fit. The lip is flexible and soft so as to snug the shaft with a minimum of friction. Thus it acts like a gasket and effectively stops leakage.



HERE ARE JOB-TESTED RECOMMENDATIONS FOR COMMON SEALING APPLICATIONS:

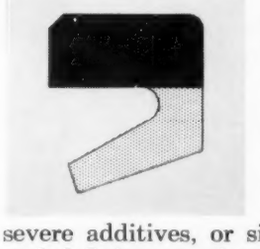


For General Service—Type LPD All Purpose. This line-contact Clipper Seal provides long life and maximum sealing effectiveness under a wide range of equipment variables. Its synthetic rubber base compound is recommended by J-M for most sealing lip applications where combined ambient and operating temperatures reach 250°F and higher. It seals practically all fluids . . . has proved highly effective against oils and greases, hot and cold water, air and many other gases and vapors. And it maintains its high efficiency despite time, high temperatures, and adverse conditions.

For Small Clearances—Split Clipper Seals. Split Clipper Seals have wide acceptance as temporary replacement seals for equipment with space or design limitations . . . to save costly downtime. Installation in inaccessible space is relatively simple and speedy. They are practically fracture-proof . . . stand up under the rough treatment . . . can be forced into position around the shaft. They give long-term, efficient sealing until a major overhaul permits replacement with solid seals.

For further data on Clipper Seals write for Book PK-71A. Address: Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.

For Continuous High Speed Operations—Type LPD Metal-Reinforced. This Clipper Seal, incorporating a metal reinforcement, is ideal for use in continuous high speed and extremely abusive service such as encountered in the steel industry. It expands and contracts with the chuck in which it is installed. It is a combination of two synthetic rubber base materials that are highly resistant to cracking, hardening and shrinking.

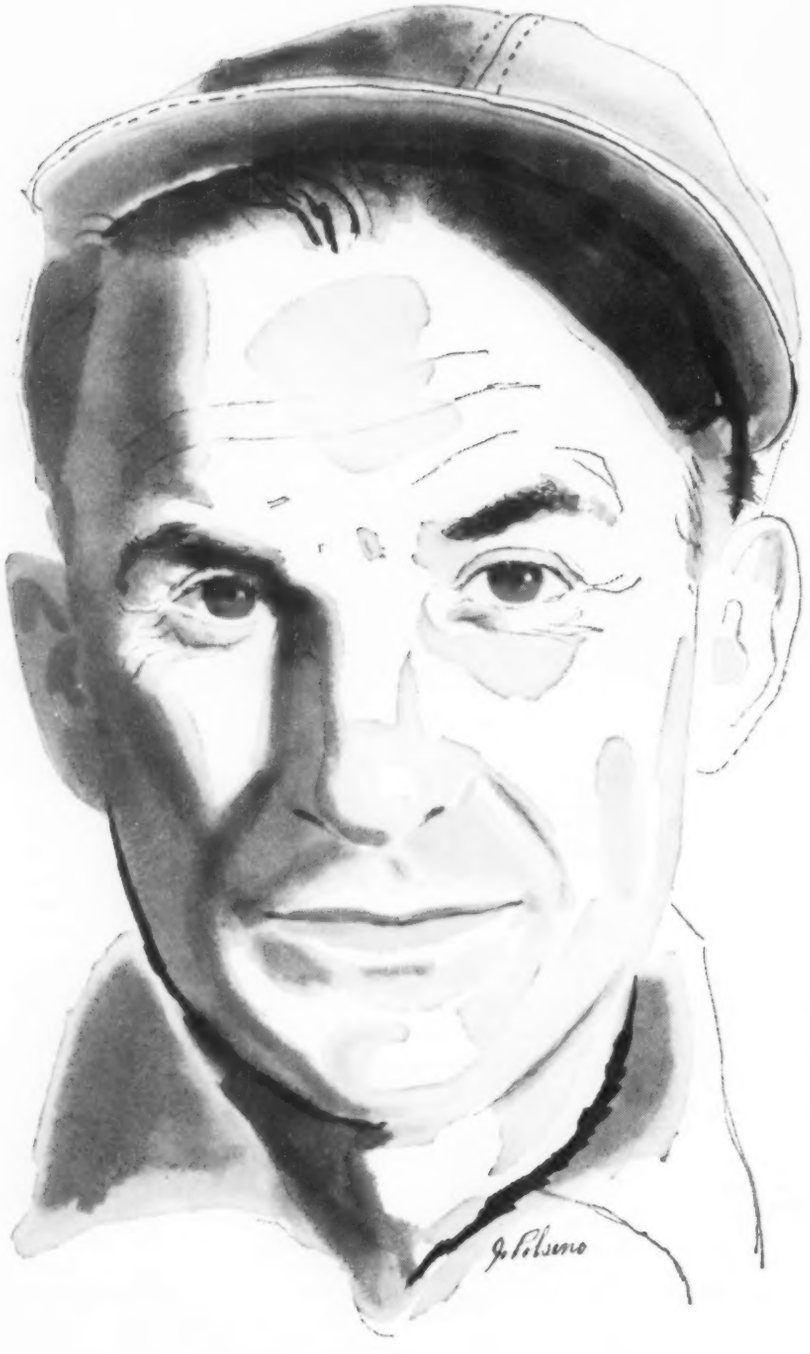


For Small Shaft Diameters—Type SS Springless. Here's the Clipper Seal designed for smaller cavities. It is made of a selected synthetic rubber base compounded to minimize swell and deterioration in corrosive applications where chlorinated solvents, lubricating oils carrying severe additives, or similar aggressive fluids must be sealed. It is a complete part in itself—contains no metal spring. No spring is required because this seal is designed to exert sufficient lip interference on the shaft to compensate for wear over a long period of time.

JOHNS-MANVILLE

100 YEARS OF QUALITY PRODUCTS . . . 1858-1958

An expert in check-out helped us check up



This test pilot of ours has checked out every new design we've had in the last two years. His business is finding answers to questions. But last week he asked *us* one.

"Why can't we rig it so I can buy U. S. Savings Bonds out of my salary, automatically?" he asked. "I want to save, but I keep forgetting about it."

We told him, of course, that we've had Payroll Savings for years. Within minutes his card was signed and he was brought into the Plan. Then we decided to check up and see how many other people on our staff had never heard about the Plan. There were quite a few.

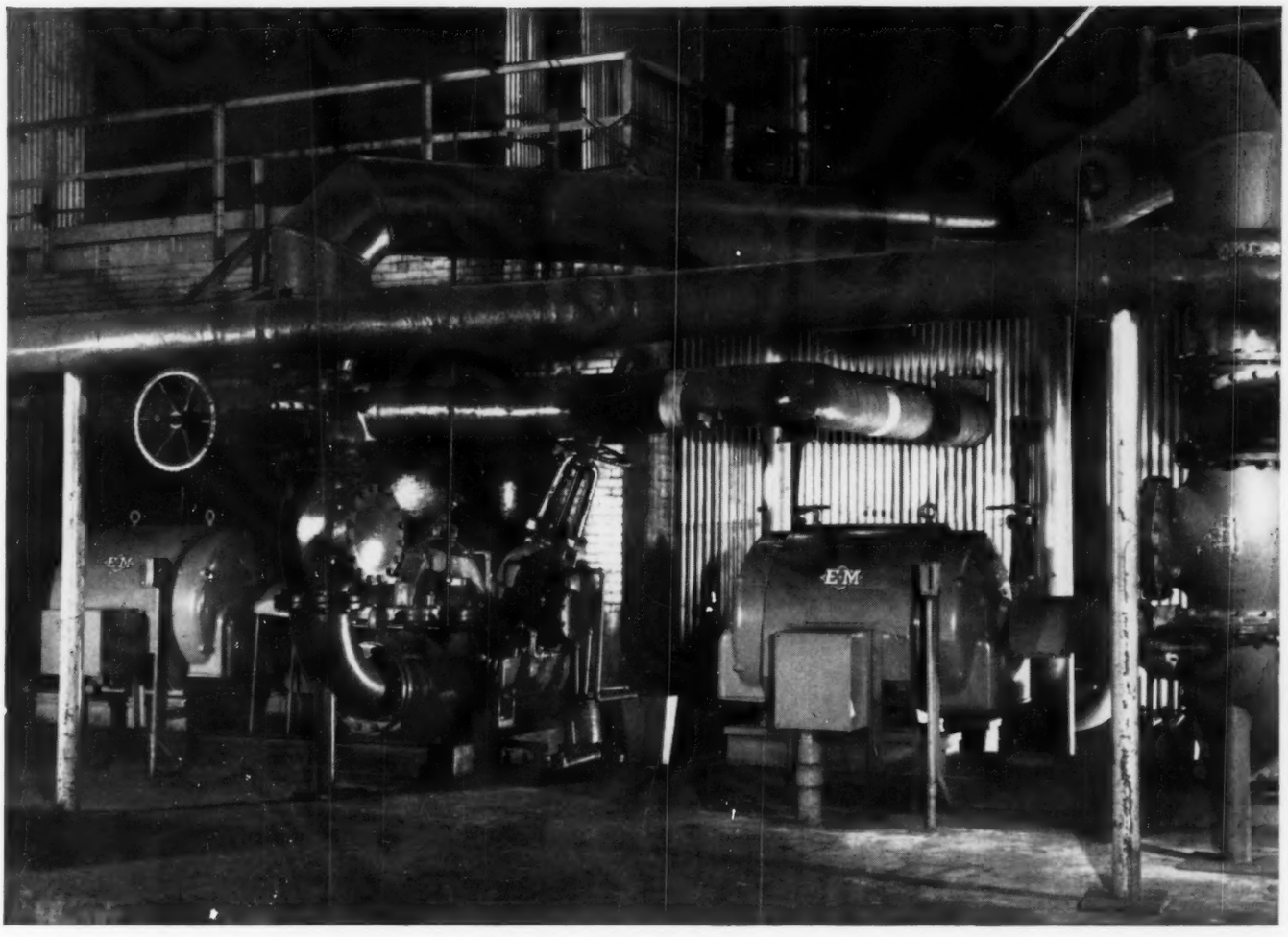
A telephone call to our State Savings Bond Director was all we needed. He supplied us with the latest booklets, folders and forms. Then he conducted a survey straight through our company and put an application blank in the hands of every single employee.

There wasn't a bit of pressure about this information campaign, but the way our people responded was inspiring. They proved that the average American wants the fine investment security that U. S. Savings Bonds provide.

Today there are more Payroll savers than ever before in peacetime. Your State Director will be happy to help you install a Payroll Savings Plan or build enrollment in one already existing. Look him up in the phone book or write: Savings Bonds Division, U. S. Treasury Dept., Washington, D. C.

IRON AND STEEL ENGINEER

THE U. S. GOVERNMENT DOES NOT PAY FOR THIS ADVERTISEMENT. THE TREASURY DEPARTMENT THANKS, FOR THEIR PATRIOTISM, THE ADVERTISING COUNCIL AND THE DONOR ABOVE



Jones & Laughlin Steel Corporation enjoys low maintenance costs on large motor drives

● Safeguarding motor operation in a steel mill is an important factor in the mill's over-all profitable operation. Motor shut down means costly maintenance projects and large production losses. Bearing failures and winding burn outs are no longer considered inevitable, and today's mill operators who are interested in continuous high-level production are taking advantage of modern motor design to insure against motor failure.

The two 400 hp, 1450 rpm, splash-proof E-M Squirrel-Cage Induction Motors above show how Jones & Laughlin Steel Corporation engineers use modern motor design to protect against motor outage. These motors, which drive centrifugal pumps supplying water to three hot strip-mill furnaces at the Pittsburgh works, have given year-in, year-out service with only routine bearing lubrication and inspection. E-M *Protective Construction* keeps water and foreign material out of vital parts, so essential to uninterrupted, trouble-free operation.

And remember, *Protective Construction* means more than physical shielding of windings and bearings with splash-proof or other protective enclosures. It includes the E-M "know-how" of motor design and special attention to the smallest details of construction. Here are some of the important features in E-M *Protective Construction:*

1. Windings custom designed for the application, repeatedly processed to keep moisture out.
2. Coil ends methodically lashed to heavy rings to prevent movement during repeated starting surges.
3. Bearings precision engineered and processed for cool, long-life service.
4. And rotors of practically indestructible cage construction, accurately balanced for vibration-free operation.

For your next *special* motor application call on your local E-M sales engineer for helpful counsel. Let him show you how E-M *Protective Construction* can help keep your maintenance costs low on large motor drives. And write the factory for E-M Foto-Facts No. 16, showing other modern motor applications in a modern steel mill.

ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

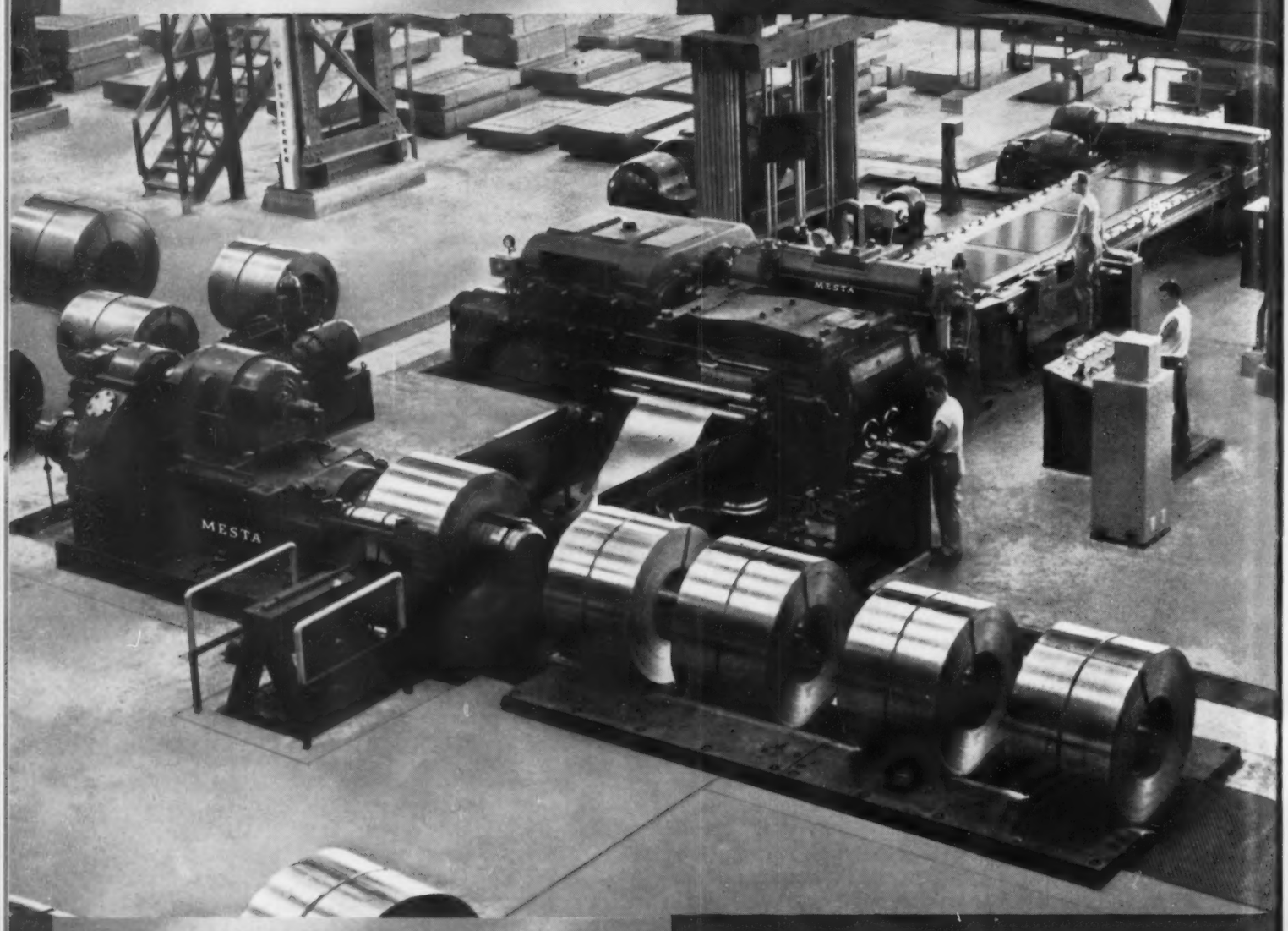
E-M

1300-TPA-2167

Specialists in making motors do **EXACTLY WHAT YOU WANT THEM TO**

Shearing* LINES

Designed and Built by MESTA



Mesta 60" Sheet Shearing Lines with Trimmers and Combination Rotary Flying Shears and Levellers Operating at McLouth Steel Corporation, Gibraltar, Michigan

* *HIGH-SPEED SHEARING, SIDE TRIMMING AND SLITTING EQUIPMENT FOR SHEET AND TIN GAUGE STRIP STEEL*

Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA

MESTA
THERE IS NONE BETTER

Personnel News...

John E. Jacobs, general manager of Lackawanna, N. Y., plant of Bethlehem Steel Co., was appointed assistant vice president of the company's steel division, with headquarters in Bethlehem, Pa. He joined Bethlehem in 1935. **Wilbur G. Smith**, an assistant general manager of the Lackawanna plant, will succeed Mr. Jacobs as general manager. Mr. Smith joined Bethlehem in 1934. **Robert M. Jordan,** assistant superintendent of the open hearth division, will become an assistant general manager.

Ray T. Winterringer has been named superintendent of the Electrical Department at Republic Steel Corp.'s South Chicago plant. He succeeds **L. A. Wynd,** who died recently. **Frank J. Zupancic** has been named to succeed Mr. Winterringer as assistant superintendent of the department. A veteran of 24 years' service with Republic, Mr. Winterringer joined the company in 1933, as a clerk in the electrical superintendent's office. He subsequently served as field engineer, instrument man-group leader and general foreman of the Electrical Department. He has been assistant superintendent of the department since September, 1946. Mr. Zupancic started with Republic in 1933 as an electrical helper. He later was electrical foreman and foreman of the electric shop before being appointed general foreman of the Electrical Department in 1946.

Clem W. Gottschalk, vice president-Traffic and Transportation, Jones & Laughlin Steel Corp., retired June 30. Mr. Gottschalk joined J&L in 1911, as a rate clerk in the Traffic Department. He rose through the offices of chief clerk, assistant traffic manager, and general traffic manager, to become an assistant vice president of the corporation in 1951. He was named to his present post on February 1, 1957. He is also the president of Union Dock Co., a wholly-owned J&L subsidiary.

Al A. Lanahan has been promoted to purchasing agent of the Granite City Steel Co. Mr. Lanahan went to work for Granite City Steel in 1937, and was assistant to the purchasing agent, raw materials, at the time of his promotion. He will serve as purchasing agent for both the Steelworks and Blast Furnace divisions.

F. A. EMM

A. O. GRIMES

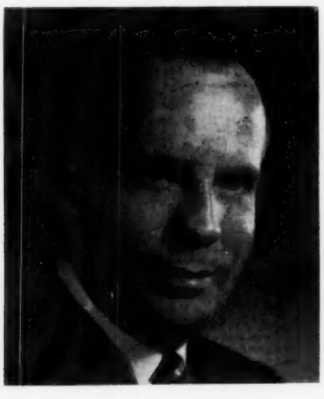
Fred A. Emm has been named assistant to the manager, Armco Steel Corp.'s Baltimore Works, and **A. Olin Grimes** has been appointed general superintendent of the stainless steel plant. Mr. Emm had been general superintendent of the plant since 1945. He began his career in the metals industry with Crucible Steel Co. of America. Before joining Armco 23 years ago, he was associated with the International Nickel Co. Mr. Grimes was formerly assistant general superintendent at the Armco plant here. He joined the company in 1929, and became foreman of the Baltimore Works' inspection and shipping department in 1942. In 1953 and 1954 he served as head of the plant's employee relations department and was appointed assistant general superintendent in 1954.

Douglas K. Forsyth has retired as manager of Republic Steel Corp.'s Truscon Steel Division in Youngstown, Ohio, and **Paul L. Bruhn** was appointed as his successor. Mr. Bruhn has been manager of Republic's Berger Division in Canton, Ohio, since September, 1955. Mr. Forsyth joined Truscon in 1919, was named department superintendent in 1935 and assistant division manager in 1938. Since June, 1948, he has been Truscon Division manager. Mr. Bruhn joined Berger in 1937 as a time study engineer. He later served as division industrial engineer and general foreman of the fabricating departments. He was named superintendent of Ber-

J. E. JACOBS

W. G. SMITH

R. M. JORDAN



R. T. WINTERRINGER

J. L. DAWSON

P. M. SCHAEFER

A. L. THURMAN

C. E. CLARK

ger's Plant No. 1 in Canton in 1946 and superintendent of both plants two years later. He was appointed assistant division manager in 1950.

John L. Dawson has been promoted to superintendent of the Blooming, Hot Strip, and Rolling Mills Department at the Aliquippa Works of Jones & Laughlin Steel Corp. Mr. Dawson, who formerly was assistant superintendent, Blooming and Merchant Mills, succeeds the late **Lewis C. Sowell.** Two assistant superintendents have been named for the Department. They are **A. Harold Ivell,** who formerly was general foreman, Blooming, Billet and Bar Mills, and **John F. McCarthy**, who formerly was general foreman, Hot Strip Mill.

Mr. Dawson has been employed at J&L's Aliquippa Works in the various rolling mills since 1933 when he was hired as a millwright helper. He has held positions as laborer, practice man, foreman-chipper; scrap and stock foreman, assistant superintendent, order and shipping; and general foreman, 14-in. Rolling Mill. He was named to the assistant superintendent post in 1947. Mr. Ivell initiated his J&L career at Aliquippa in 1936 as a metallurgical inspector. He has held positions as sales and production trainee; practice engineer, turn and pit foreman, and blooming mill turn foreman. He was promoted to general foreman in February of this year. Mr. McCarthy joined J&L at Aliquippa in 1956, following an extensive rolling mill career with Steel Co. of Canada, and as a hot strip mill consultant for USINOR, France: SOLLAC, France; Ougree Marihaye, Belgium; and Australian Iron and Steel, Australia.

Paul M. Schaefer has been appointed superintendent of Wheeling Steel Corp.'s By-Product Coke Plant. Mr. Schaefer succeeds **R. A. Swift**, who retired after 31 years with Wheeling Steel, including 14 years as coke plant superintendent. Mr. Schaefer began his Wheeling career in 1928 as a heater foreman at the coke plant. Prior to that, he had been with Weirton Steel Co. He was appointed assistant superintendent of the Wheeling Steel Coke operation in 1946.

Astor L. Thurman has been named manager of West Virginia Works, Connors Steel Division, H. K. Porter Co., Inc. He joins Connors from Mannesmann-Meer Engineering and Construction Co., where he was executive vice president. He previously was assistant vice president with Aetna Standard Engineering Co., in charge of sales, purchasing and production; and steel mill application engineer with General Electric Co.

Charles E. Clark has been appointed assistant superintendent of the 98-in. cold strip mill department at the Cleveland, Ohio, plant of Republic Steel Corp. Mr. Clark joined Republic as a tester at the company's Warren, Ohio, plant in 1936. He was transferred to the Massillon Enduro plant as a laboratory assistant in 1940. In 1947 he moved to Canton as a mill metallurgist. He was named chief inspector at the Massillon Enduro division in 1949. Five years later he was named general foreman of the 98-in. cold strip mill finishing department at Cleveland.

Harold G. Ingersoll, Jr., was elected president and general manager of the Ingersoll Steel Division of Borg-Warner Corp. Mr. Ingersoll, who formerly was executive vice president and general manager, succeeds **L. G. Porter** who now becomes chairman of the Division's supervisory board. Mr. Porter is executive vice-president of Borg-Warner, the parent corporation. Mr. Ingersoll joined the Division in 1951. **Howard E. Morison,** who has been vice president of the Division, was made executive vice president.

Mitchell P. Kartalia was named general manager of the Square D Co. marketing division. Mr. Kartalia will be responsible for all marketing division programs, including distributor relations, field office operations, national advertising, market research, product development liaison, and export activities. Mr. Kartalia, who has been sales manager of Square D's distribution equipment division, will make his headquarters in the Detroit, Mich., executive offices, reporting to the president. He succeeds **Frank Roby**, who has resigned. **Robert E. King** succeeds Mr. Kartalia as distribution equipment sales manager.

M. P. KARTALIA

R. E. KING

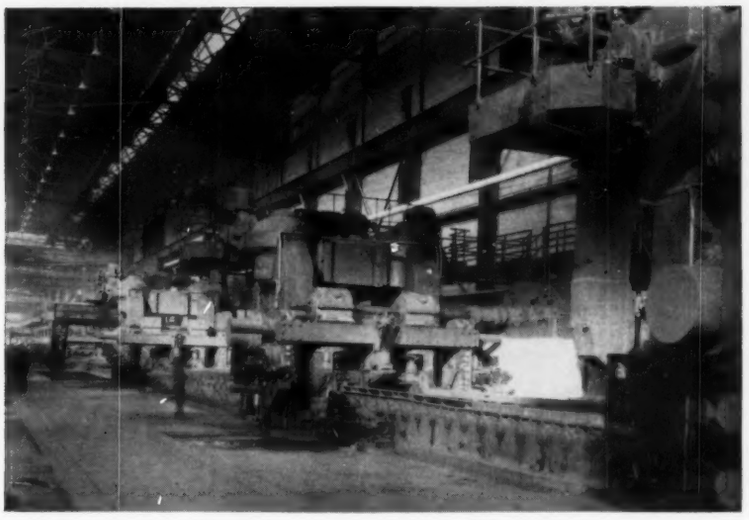
POOLE Flexible Couplings

Look at these features—many of them exclusive with the patented POOLE:

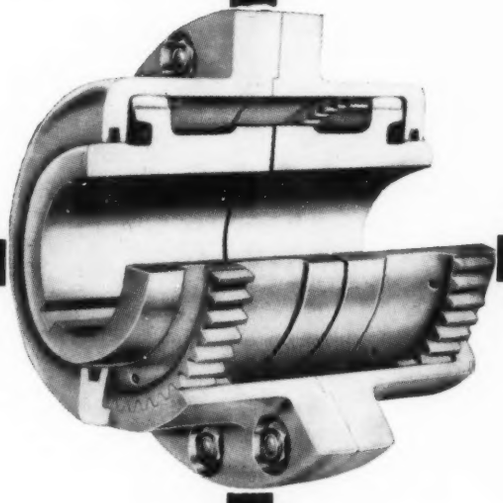
Adjusts itself to all conditions, leaving its members free to float without strain to parts.

Geared type providing great strength, the highest efficiency of modern flexible coupling design.

No flexing materials to crystallize or break . . . No welded parts . . . Filled with oil, self-lubricating . . . Oil tight, dust tight . . . Permits free lateral float . . . Stronger than shafts it connects . . . Compensates for both off-set and angular misalignment.



Steel mill drives equipped with POOLE FLEXIBLE COUPLINGS.



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the better

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E. L. CASEY

R. I. PETERS

R. E. SCHEEL

E. H. BURKE

Elmer L. Casey was elected president of M. H. Treadwell Co., Inc. He succeeds **Francis J. Lantry** who after 52 years with the company, the last 10 as president will become chairman of the board and chief executive officer. Mr. Casey joined Treadwell in 1956 as executive vice president. Prior to that he had been with the E. W. Bliss Co., as vice president and the Scaife Co. as vice president.

Robert I. Peters was named assistant chief engineer Heil-Process Equipment Corp. At the same time, **R. E. Scheel** was named Western sales manager, and **R. A. Brown** was named Chicago sales engineer. Mr. Peters was formerly Western division sales manager. Mr. Scheel has been with the company for 8 years, first in Cleveland and more recently in Chicago as district sales engineer. Mr. Brown was formerly district engineer in the Detroit, Mich., office.

Edwin H. Burke has been appointed to the position of chief engineer at The Morgan Engineering Co. Mr. Burke joined Morgan in 1955 as chief engineer of all mill machinery. In his new capacity, he will be in charge of all engineering of cranes and mill equipment the company manufactures. Starting as an apprentice engineer with the Carnegie Illinois Steel Corp., Mr. Burke later worked as a design engineer with United Engineering & Foundry Co. Before joining Morgan he was with the Crucible Steel Co. of America at Midland, Pa.

Clarence D. Thurnes has been appointed superintendent of the Continuous Welding Furnaces and Primary Finishing Department, Wheeling Steel Corp. Mr. Thurnes is a 38-year Wheeling veteran, starting in 1920 as a pipe threading machine operator at the Benwood Works of Wheeling Steel & Iron Co., predecessor to Wheeling Steel Corp. His entire career has been at the Benwood operation. Prior to this promotion, he was assistant superintendent of the Tube Mill Department. **Louis F. Jagucki** has been appointed superintendent of the Finishing, Warehousing and Shipping Departments. Mr. Jagucki, a graduate of Case Institute of Technology began his Wheeling Steel career in 1946 as an estimator at the Benwood plant. Prior to this appointment, he had been chief plant engineer at Benwood. **Ross P. Long** was appointed superintendent of Engineering and Yards. He has been with Wheeling Steel since 1925, starting as a rigger at the Benwood plant and advancing through supervisory positions in construction, transportation and maintenance.

Charles M. Rader has joined Heyl & Patterson, Inc. as a contracting engineer. Mr. Rader served Treadwell Construction Co. for the past 14 years in the engineering and sales of steel mill equipment.

Ben P. Finkbone has retired after 48 years' service with Armco Steel Corp. Mr. Finkbone was a product engineer in Armco's Research Division. He joined Armco in 1910 as a scrap bundler in the Middletown Works' galvanizing department. He progressed through various positions and became superintendent of the department in 1919. In 1930, Mr. Finkbone was appointed a galvanizing consultant in the Research Division and moved up to product engineer in 1940.

Louis Schlossberg has been named manager of the newly formed Strip Mill Sales Division, E. F. Houghton & Co. **William C. Johns** was named manager of the Bar, Tube and Wire Division.

LOUIS SCHLOSSBERG

W. C. JOHNS

The overwhelming majority of cranes and pulpits being equipped with air conditioning are Lintern equipped.

The reasons for this are contained in our 20-page Bulletin AC-573 which describes Aire-Rectifiers for each temperature range of cab, also models for pulpits.

Write for copy today.

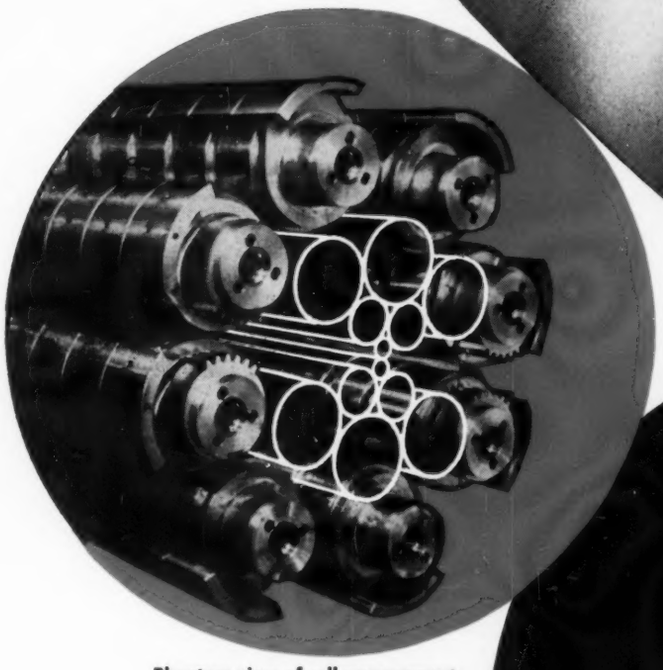
Larco, inc.

DISTRIBUTOR OF LINTERN CORPORATION PRODUCTS

ROUTE 20, EAST • PAINESVILLE, OHIO

This 80" WATERBURY FARREL SENDZIMIR MILL

maintains precise gauge across the width and along length of strip



Phantom view of roll arrangement

This Sendzimir cold strip mill rolls 80" wide low carbon steel from hot rolled thickness to .024" with total gauge variation of .0004". Similar uniformity is being regularly obtained on Sendzimir cold strip mills rolling brass, copper, aluminum, stainless steel, silicon steel, etc.

CONSIDER THE ADVANTAGES OF THE SENDZIMIR COLD MILL

- Extreme Accuracy In Gauge, Due To Uniform Support Throughout Mill
- Elimination Of Intermediate Anneals
- Greater Reductions Per Pass
- Highest Surface Finish
- Quick And Simple Roll Changes
- Low Initial And Maintenance Costs

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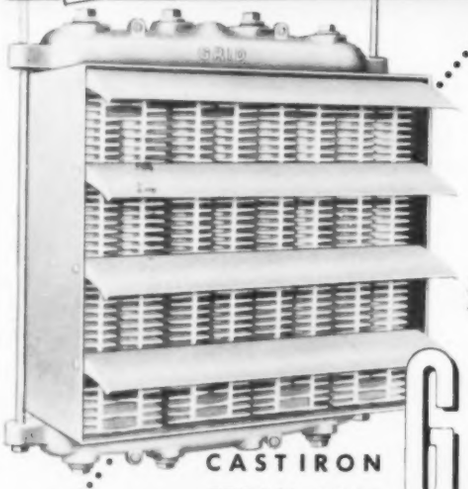
Backing Roll Support

Sendzimir Support

Corrosion in heating equipment Ends

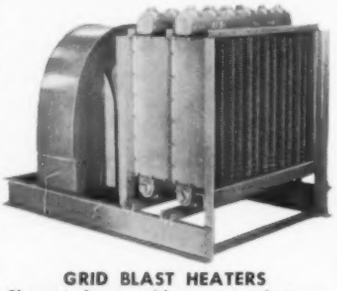


when you install GRID CAST IRON STEAM HEAT TRANSFER SURFACE

UNIT HEATER MAINTENANCE ENDS TOO!

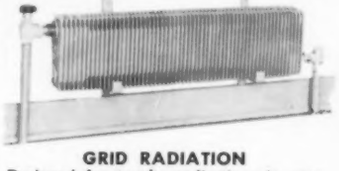
You once and for all eliminate internal electrolytic corrosion because all metals in GRID Cast Iron Steam Heat Transfer Surface that are in contact with steam are similar . . . not 2 or 3 different metals that promote corrosion to cause leaks and breakdowns. GRID Cast Iron Steam Heat Transfer Surface also eliminates external corrosion because its cast iron construction resists acids or fumes in the air. When corrosion in heat transfer equipment ends, maintenance ends . . . it's as simple as that, no mystery, no magic, no "sales" talk. Your heating problems are no longer problems . . . you do away with high maintenance costs, repair work and the nuisance of leaky heating equipment.

GRID Cast Iron construction eliminates the use of reducing valves where high steam pressures are used. It is designed to withstand steam pressures up to 250 P.S.I. . . . 450° temperature. GRID Cast Iron Steam Heat Transfer Surface does away with replacement costs because GRID is built to last for years . . . operating successfully without maintenance in many plants since 1929. Sounds worth looking into? Then get the complete story today . . . come the heating season, you will be glad you did.



GRID BLAST HEATERS

Shown in fan assembly . . . rugged, strong and economical heat transfer surface designed for the tough job . . . for low and high steam pressures . . . requires less labor for installation and less cubical space.



GRID RADIATION

Designed for tough applications in conjunction with high steam pressure systems, GRID Radiators eliminate the use of pressure reducing valves . . . will withstand steam pressures up to 250 P.S.I. . . . adaptable for factory, shop offices, store rooms laboratories, etc.

Send for the complete story on GRID Unit Heaters, GRID Blast Heaters, and GRID Radiation for steel plant use . . . it is contained in GRID Products Catalog No. 956. Write today for your copy.

D. J. MURRAY MANUFACTURING CO.

WAUSAU • WISCONSIN

OUR 75TH YEAR 1883 TO 1958

J. W. HOLZWARTH

R. J. MUTH

John W. Holzwarth was named manager of the new western district office of The Electric Furnace Co. at Santa Ana, Calif. Mr. Holzwarth originally joined the organization in 1940 and has served in the shop, erection, engineering and sales departments.

Robert J. Muth, former Los Angeles branch sales manager for Exide Industrial Division of the Electric Storage Battery Co., has been transferred to the Philadelphia headquarters of the firm, as field sales manager.

Obituaries

Jay T. Osler, 73, consultant for the Blaw-Knox Co., East Chicago, Ind., plant, died July 4. Chairman of the board of Continental Foundry and Machine Co. before its acquisition by Blaw-Knox in 1955, Mr. Osler was active in the steel industry for 50 years.

Call or Write **STAMCO** *for...*

Corrugating and Complete Line of Culvert Equipment—Slitting and Coiling Equipment for Ferrous and Non-Ferrous Material in All Capacities—Warehouse and Steel Mill Cut to Length Lines for Shearing and Levelling Sheets from Coils—Shears for Shearing Sheets and Plates Both Underdriven and Overdriven Types in all Capacities up to 1¼" plate.

STAMCO, Inc., New Bremen, Ohio

NOW-ALLOY CHAIN REPAIR SERVICE

in PITTSBURGH and HAMMOND

For greater safety and economy, have your Alloy Sling Chains returned to either our Pittsburgh or Hammond plant for repair, inspection and testing, at nominal cost.

S. G. TAYLOR CHAIN CO., Inc., Hammond, Ind. and 3505 Smallman St., Pittsburgh 1, Pa.

BUILT BIG . . . TO CLEAN BIG

Giant Pangborn unit Rotoblasts loads up to 12,000 lbs. in minutes!

A side view of the 72 cu. ft. Pangborn Rotoblast Barrel. Pangborn Barrels available in 1½, 3, 6, 12, 18, 20, 32, 72 and 102 cubic foot sizes

How do you build a giant blast cleaning barrel? If you're Pangborn, you use steel, inches thick. You put in the heaviest apron conveyor ever made. You incorporate the patented abrasive separator, abrasive-tight door, simplified Pangborn construction. You power it with two Rotoblast wheels that hurl *60 tons of abrasive an hour.*

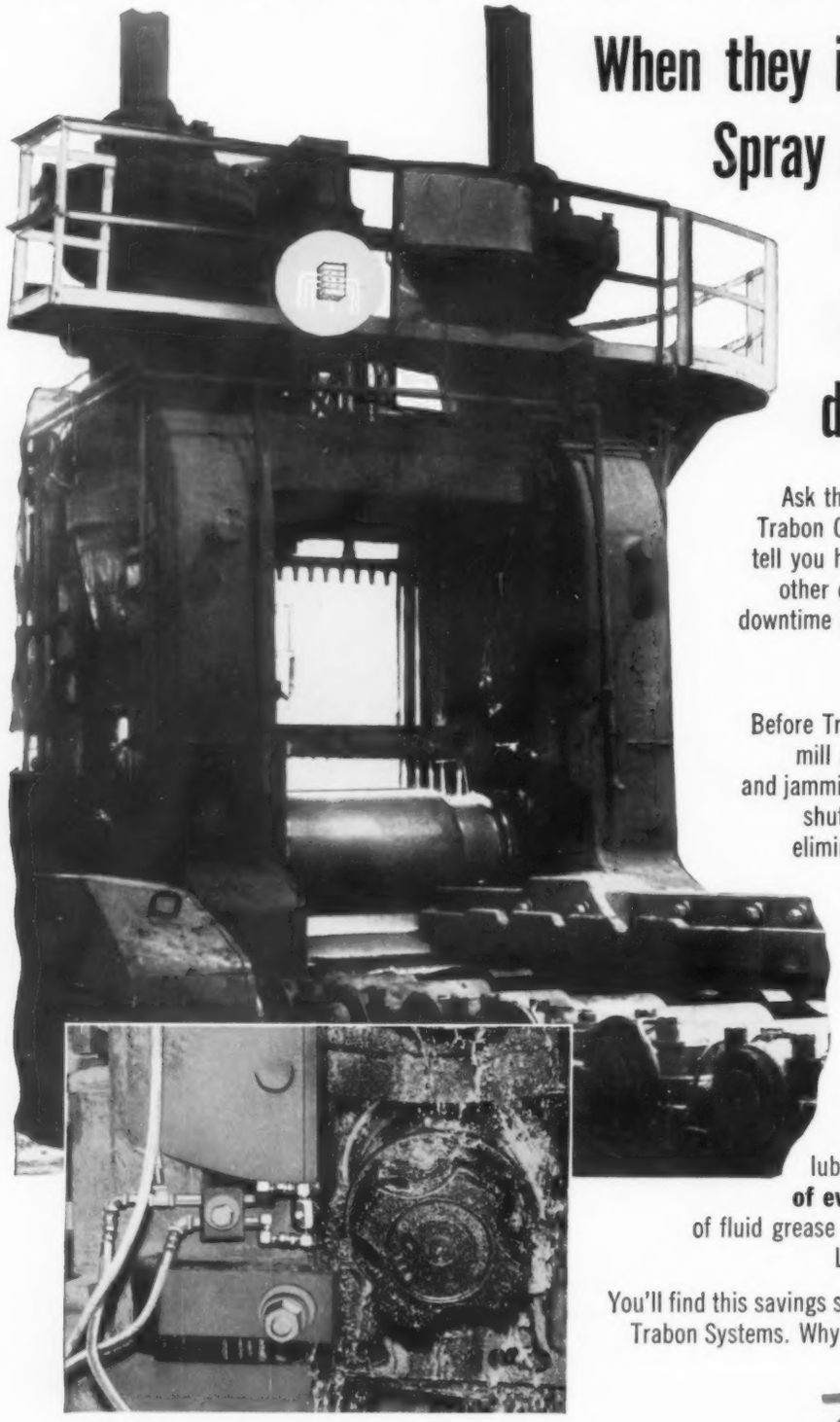
Sure, it's tough to build . . . but it's worth it when you come up with a 72 cu. ft. Pangborn Rotoblast® Barrel! This unit cleans 6-ton loads *in five minutes* and gives the lowest operating and maintenance costs in the blast cleaning field! It's one of many Pangborn Rotoblast Machines. There's one for *your* problem.

The Pangborn Engineer in your area will be glad to take off his coat and go to work on your cleaning problem at no obligation. And for complete information on Rotoblast Barrels, write to: Pangborn Corp., *4400 Pangborn Blvd., Hagerstown, Md. Manufacturers of Blast Cleaning & Dust Control Equipment.*

Clean it fast with Pangborn ROTOBLAST®

TRABON

CENTRALIZED LUBRICATING SYSTEMS



When they installed a Trabon Spray System here... they saved several hundred thousand dollars in six years

Ask the men who operate this 40" mill about Trabon Centralized Lubricating Systems! They'll tell you how a Trabon spray system, along with other changes, saved five expensive hours of downtime **every** week. How increased production time **alone** ran savings to many thousands of dollars the first year.

Before Trabon, critical roll neck bearings in this mill at an Ohio steel plant were burning up and jamming the rolls. Once Trabon was installed, shutdowns due to lubrication failures were eliminated. Bearing life more than doubled. Lubricant consumption dropped from 20 drums to 3 drums a week. For the six years Trabon has been protecting these bearings, savings in production time alone have totaled several hundred thousand dollars.

The Trabon automatic system is connected to an air pressure supply which is in constant operation. Spray lubricant is delivered for **20 seconds out of every minute** with just the right amount of fluid grease needed by the four roll neck bearings. Lubrication is dependable and positive!

You'll find this savings story repeated in **any mill** equipped with Trabon Systems. Why not get technical data by writing today!

Insets show a Trabon feeder and two spray nozzles protecting roll neck bearings on a 40" mill. Despite heat, water and dirt, Trabon delivers an exact, metered amount of lubricant to all bearings automatically.

Trabon

Trabon Engineering Corporation

28785 Aurora Road • Solon, Ohio

Centrelgrd OIL AND GREASE SYSTEMS *Mastergrd* CIRCULATING OIL SYSTEMS

Equipment News...

FUSED SILICA BLOCKS

△ The Pittsburgh Corning Corp. has announced a new material which should have a wide range of applications in the chemical and chemical process industries, as well as in many areas of the metallurgical, electrical, petroleum and nuclear energy fields.

Called Foamsil, the new material is 99 per cent pure fused silica in cellulated form. Details of the manufacturing process have not been revealed, beyond the fact that a specially designed high-temperature furnace 70 ft long is used.

The pure silica, activated by a foaming agent (a form of carbon), foams into millions of tiny, non-interconnecting bubbles. When cooled, a lightweight, rigid, inorganic block, with a closed cell structure, results.

Dimensional stability of the material is exceptional. It does not warp, shrink or slump during rapid temperature changes. When subjected to intense heat (such as that of a steel-cutting oxyacetylene torch) and then water-quenched, it does not crack or spall.

A low expansion coefficient of 3.5×10^{-7}, about one-eighteenth that of low carbon steel, gives the material volume stability throughout its entire temperature operating range. For operating temperatures up to 2200 F, Foamsil actually expands whereas most insulations shrink. It has been heated in a furnace at 1600 F for more than two years without any evidence of deterioration.

Light in weight (10 to 12 lb per cu ft) and having a compressive strength of 130 to 210 psi, Foamsil can be used as a load-bearing surface to eliminate some of the supporting and reinforcing structure required with conventional material.

The material offers continuous insulating protection and withstands thermal shock within the range of −450 to 2200 F. The insulating value of one inch of Foamsil is equivalent to that of 18 in. of acid brick at an operating temperature of 250 F. It is unaffected by all acids with the exception of hydrofluoric and hot phosphoric.

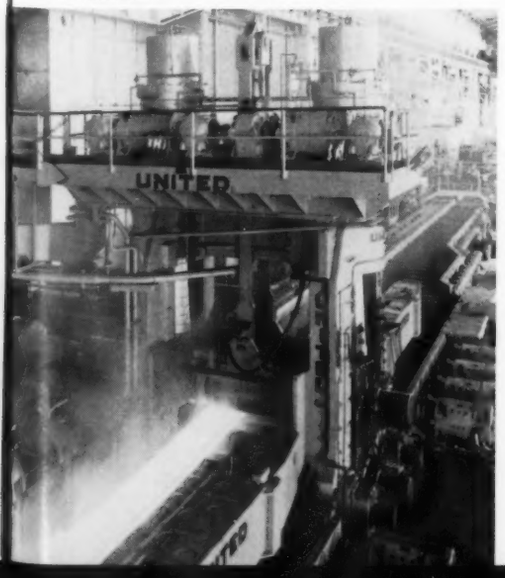
Laboratory and industrial applications show the new material to be ideal as a lining inside tanks and pipelines that contain hot acids of any concentrations. The sealed silica cells prevent absorption of the acids, inflammable solvents or vapors, thus assuring full original insulating value throughout the life of the equipment it serves. Because of the absence of capillary action, Foamsil also cannot act as a wick for transfer of inflammable liquid or gas to critical areas.

Concrete, brick or steel stacks subjected to corrosive atmospheres may be readily lined with the light weight acid-resistant material. It can likewise be used as underground thermal and electric insulation.

The material is available in blocks up to 17 in. x 22 in. x 3 in., and in curved segments, wedges, etc. It is easily cut with saw-like tools.

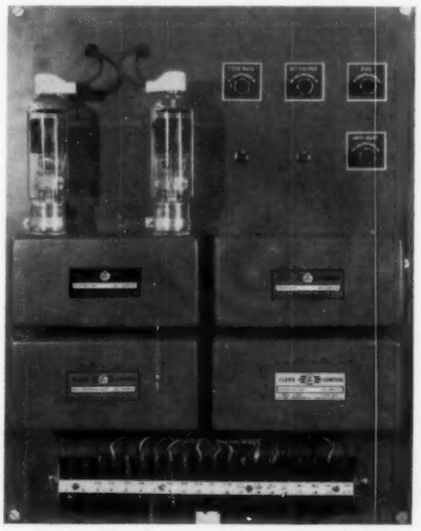
SLABBING MILL

The Broken Hill Proprietary Co., Ltd., has recently put into operation at its Port Kembla, New South Wales Works this 45-in. x 115-in. two-high reversing slabbing mill, designed and manufactured by the United Engineering and Foundry Co. Other United equipment now in operation at Broken Hill includes a semi-continuous hot strip mill, a two-stand temper mill, as well as auxiliary equipment.



REGULATOR

△ A new all-purpose two-stage regulator combining the best features of magnetic and electronic amplifiers has been developed by the Clark Controller Co. Special features are electrically isolated inputs, compactness and minimization of drift. The regulator will be applied on adjustable-voltage d-c drives and other applications for



voltage and current regulation in speed, tension, position and similar systems.

The new Bulletin 5100 Type "GS" regulator has a magnetic amplifier control input stage and a grid-controlled rectifier power output stage. A new and unique "grid switching" circuit controls the output rectifiers.

The Type "GS" regulator offers high reliability and long life virtually free of maintenance. The basic regulator is manufactured as a compact and complete unit. Each of the four principal components; exciter unit (power), grid switching unit (control), reference unit and time delay unit are unitized and potted in individual steel drawn enclosures. Isolation of trouble, replacement or modification can be quickly accomplished.

The magnetic-amplifier control stage provides multiple electrically-

New Wheelabrator® Ultra-Filtration keeps control room air "vacuum" pure

Wherever ultra-clean air is essential, as in this electrical equipment control room of a leading steel mill, low-cost Wheelabrator **Ultra-Filtration** provides the most effective and economical method you can employ.

Ultra-Filtration removes even the most minute particles of foreign matter from the atmosphere, leaving the air cleaner than clean — as close to absolute purity as any practical means can achieve.

Control and motor rooms, laboratories, instrument and spectograph areas — or areas that must have dependably and consistently pure air — are best protected by Wheelabrator Dustube Ultra-Filtration. Machinery and instruments function more consistently with minimum downtime and maintenance caused by air-borne contaminating particles. And the Ultra-Filtration unit itself works continuously and automatically, with no attention and practically no maintenance cost.

For detailed information write today for Bulletin No. 558-D

WHEELABRATOR
CORPORATION

396 South Byrkit Street, Mishawaka, Indiana
Canadian Offices: Scarborough (Toronto) — Montreal

isolated inputs at low power and impedance levels in a completely static unit. The power output stage utilizing a single pair of gas-filled rectifier tubes provides high power output with fast response and inversion ability. This combination allows simplicity and flexibility in regulating system circuit design.

The regulator is available in three sizes: 5 amp maximum, 12.8 amp maximum and 36 amp maximum with intermediate ratings available. A-c supply is 220/440/550-volt, single-phase, 60-cycle. A modification for 50 cycles is available. Standard modifications to provide timed rate response, current limit control and dual regulation are provided.

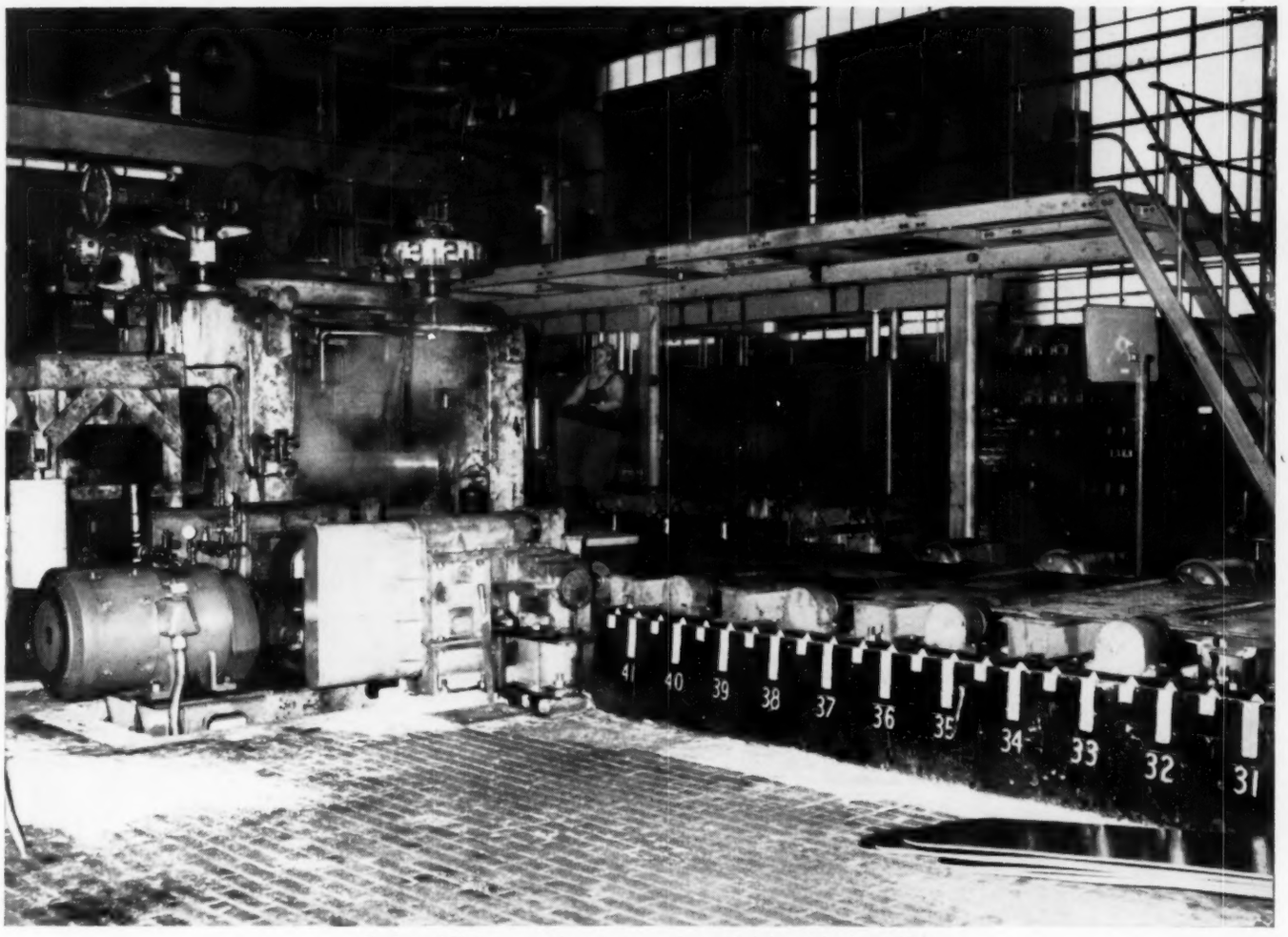
PALLET LIFTER

△ Tin plate, in coils weighing more than 15,000 lb each, is moved quickly and safely with "C" hook pallet lifters at Jones & Laughlin Steel Corp.'s plant at Aliquippa, Pa.

In a new method of shipping, devised to meet a demand of canmakers for tin plate in larger units, the coils are strapped on wooden pallets for transportation. The lower arms of the pallet lifters are designed to slip under pallets easily, supporting both the pallet and the coil. Loaded pallets can be delivered to any point within the range of the overhead crane, and can be positioned as desired on freight cars or barges.

The pallet lifters, manufactured by Heppenstall Co., are intended

Lower arms of the pallet lifter slip under the pallet to which the coil is strapped. A counterbalance keeps the lifter level at all times.



Packaged M-G sets and controls are located right at the hot mill in Revere Copper and Brass, Incorporated's New Bedford, Mass. plant

Reliance Packaged Drives cut Modernization Cost 20%

Instead of one large motor-generator set, Revere Copper and Brass, Incorporated used five packaged V★S Drives to power the edger and tables on their rebuilt hot mill.

Reliance Drives package the M-G sets with controls and put them right at the mill itself. Conduit runs are of minimum length, which reduced not only material costs but construction time.

Control installation was vastly simplified. Each V★S Unit was prewired and pretested before shipping. The complete V★S Cabinets had only to be set in place and connected. Extra construction was not required for a generator room.

Packaged V★S Drives cut costs for Revere and gave more flexibility of operation and greater ease of maintenance. Reliance Packaged Drives will reduce drive installation and operating costs for any type of mill.

For complete details contact your Reliance representative, or write today for Bulletin No. D-2506. L-1586

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 118A CLEVELAND 17, OHIO
CANADIAN DIVISION: TORONTO, ONTARIO
Sales Offices and Distributors in principal cities

FELLER ENGINEERING CO.

presents

SCHLOEMANN

SCHLOEMANN-MKW-Type Cold Rolling Mills with driven back-up rolls

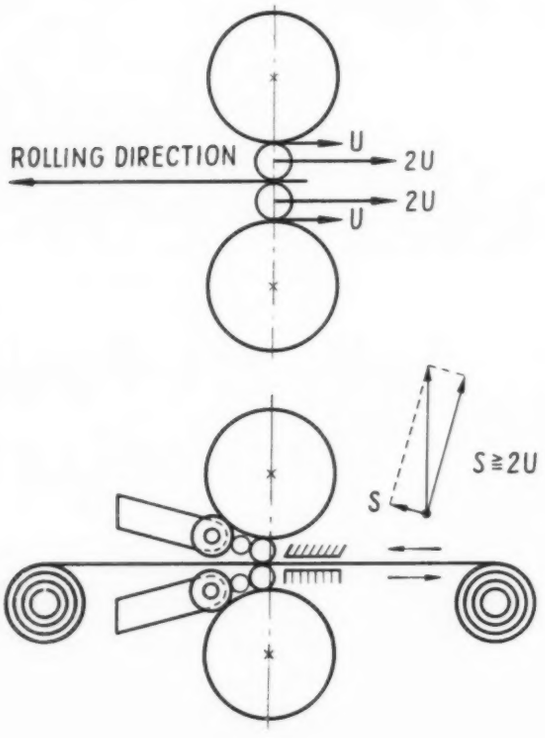
The economical use of a cold rolling mill is limited by the diameter of its work rolls, on which the efficiency of cold shaping directly depends. With the customary four-high mills with driven work rolls the diameter is determined by the torque to be transmitted. These mills are therefore only suitable for a limited range of strip gauge.

Driven Back-up Rolls

With driven back-up rolls, it is not necessary for the work rolls to transmit torque. Their diameter can therefore be reduced if rolling requires it. However, as the work rolls are now driven on their circumference by force U, they are stressed contrary to direction of rolling by the lateral force 2 U which is twice as high and may cause troublesome deflexion. Because of this, the advantages of back-up roll drive can only be fully utilized, if a solution is found to the problem of lateral flexion of the work rolls even for big drive forces.

SCHLOEMANN-MKW-Design

This MKW-design solves the problem of the undesirable lateral forces. The work rolls are supported over the whole width of the roll barrel, also laterally. By shifting the rolls out of the center line of the roll stand, static lateral force S results which is equal to or bigger than the double dynamic force 2 U and fixes the position of the work rolls independent from the direction of rolling. Deflexion of the work rolls is eliminated by lateral support and the static component of rolling pressure, not by the strip tension of the reel. For this reason, strip tension in front of the rolls can be equal to or even bigger than reel tension beyond the roll gap. Therefore, by the MKW roll arrangement, great torques can be transmitted onto the material regardless of strip section or the tensile strength of the material.



Summary

On SCHLOEMANN MKW cold rolling mills the work roll diameter may be freely chosen without regard to torsional or bending forces and is thus adaptable to rolling requirements. When rolling strip, reel and braking forces need only be used with regard to rolling requirements. High pass reductions are possible even with rolls of small diameter. These result in close tolerances of the length and width of the rolled material.

FELLER ENGINEERING CO., 1161 EMPIRE BUILDING, PITTSBURGH 22, PA.

for loads up to 18,000 lb. A counterbalance on each pallet lifter keeps it level at all times, whether loaded or unloaded.

The traditional practice has been to ship tin plate in packages of flat sheets, each about the size of a standard newspaper page. The largest coils shipped weighed 7500 lb. A typical king-sized coil is 34½ in. wide and approximately 15,000 ft long. It contains enough tin plate for more than 110,000 cans.

MOISTURE EXTRACTOR

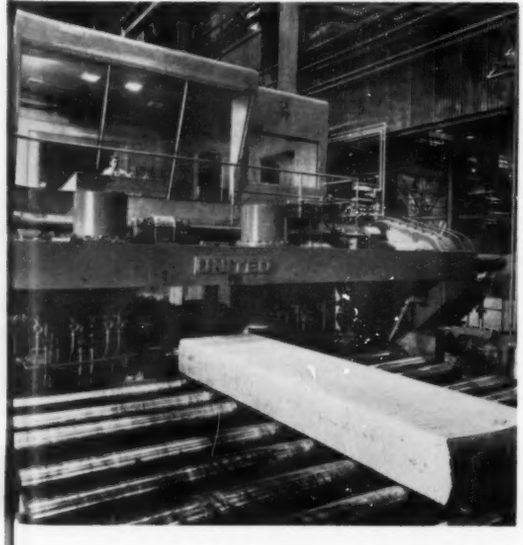
△ A centrifugal moisture extractor has been developed by The Johnson-March Corp. that removes free moisture from wet scrubber exhausts. Five sizes are available to handle a range of exhaust gases from 10 to 35 thousand cfm. The new extractor changes the direction of exhaust gas flow from a vertical to a cyclonic path. Centrifugal action imparted by stationary impeller blades removes all free moisture along with some of the entrained dust or solid particles. Moisture impinges on the inside of the outer shell and collects at a drain outlet for disposal.

Cleaning and inspection of the all-welded steel extractor is facili-

▲

AIR COOLED PULPITS

In the new 200-million-dollar Kaiser Aluminum & Chemical Corp.'s plant at Ravenswood, W. Va., rolling mill pulpits are equipped with Lintern Pulpit Aire-Rectifiers. The hotline includes three giant rolling mills. Larco has supplied 25 crane cab air conditioners and 4 pulpit air conditioners for the Ravenswood plant.



Vapor-Tight Lighting —by Adalet

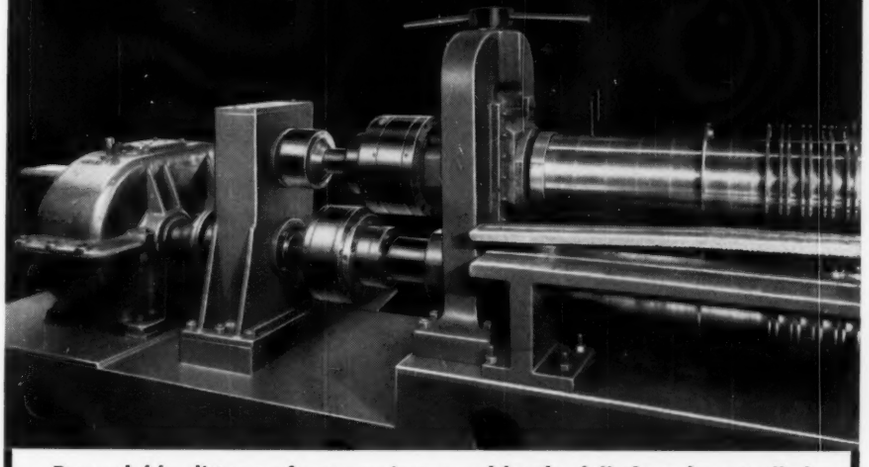
Complete in One Package

Designed for the man who installs. From junction box to aluminum guard and screws, all Adalet lighting fixture parts are shipped *complete in one package* —ready to install.

SEND FOR BULLETIN E

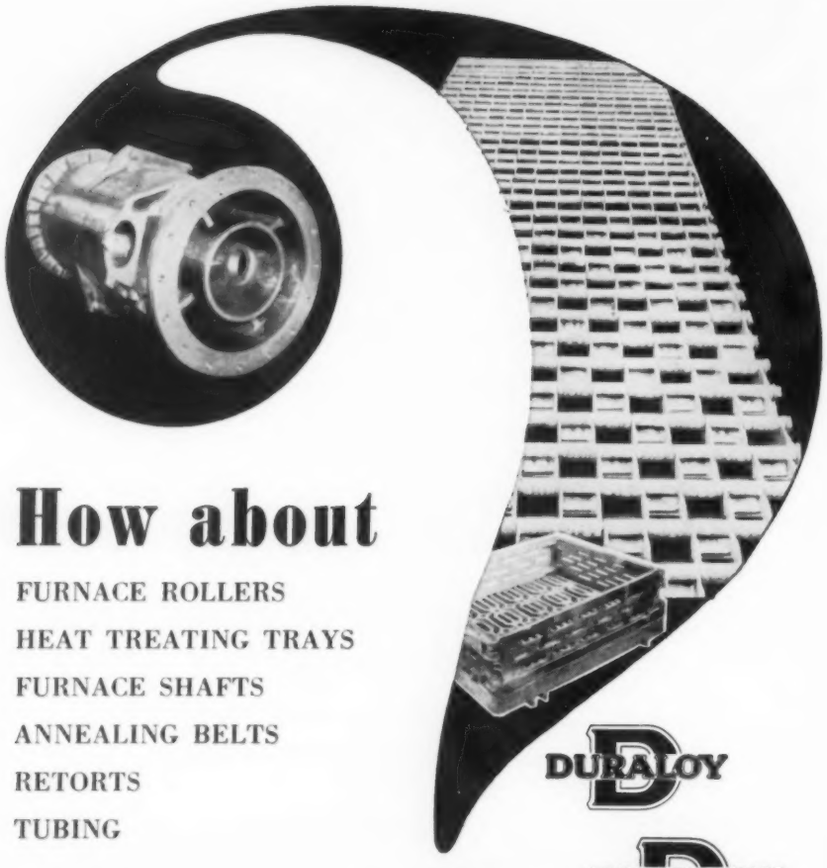
THE Adalet MANUFACTURING COMPANY
14300 LORAIN AVENUE • CLEVELAND 11, OHIO

for slitter dependability specify MARLAND ONE-WAY CLUTCHES



Dependable slitter performance is assured by the full-phased, controlled roller action design of Marland One-Way automatic freewheeling clutches. Full-phased roller action permits positive, instantaneous slitter driving or absolute slitter freewheeling for complete protection to the material being processed. For clutches that will give outstanding service and long life on metal slitting, rolling and drawing applications, refer to Marland One-Way Engineering Manual No. 56.

MARLAND ONE-WAY CLUTCH COMPANY
ELM AND WASHINGTON AVES., LA GRANGE, ILLINOIS



How about

FURNACE ROLLERS
HEAT TREATING TRAYS
FURNACE SHAFTS
ANNEALING BELTS
RETORTS
TUBING

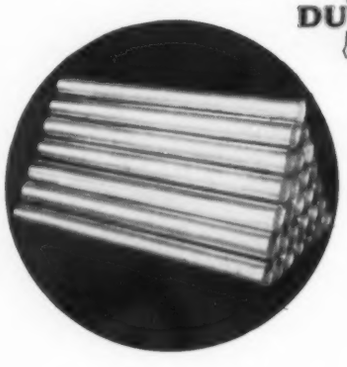
DURALOY

DURASPUN

Which are
Heat Resistant

Corrosion Resistant

Abrasion Resistant



When ready to order, how about checking with us here at DURALOY? For more than thirty years we have specialized in high-alloy castings. In fact, we were among the first to produce static castings and the first to produce centrifugal castings. We are old hands at producing castings alloyed to fit each specific requirement and to finish them to any extent desired.

Melt, castings and finishing are carefully controlled and quality tested by our staff of metallurgists, chemists, X-ray and gamma ray technicians. If you would like more preliminary information, send for Bulletin No. 3150-G.

The DURALOY Company

OFFICE AND PLANT: Scottdale, Pa.

EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
ATLANTA OFFICE: 76—4th Street, N.W.
CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.

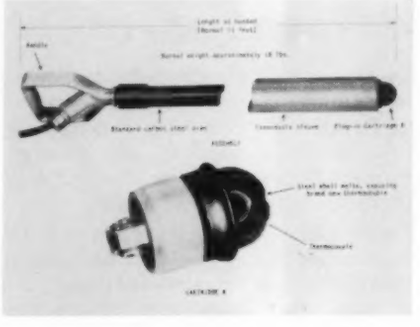
tated by two, water-tight, neoprene gasketed inspection doors and a backwash nozzle at the apex of the stack. The operator controlled spray both cleans the vanes and flushes the stack. The nozzles consume 45 gpm at 60 psi pressure during cleaning operations.

Flexibility keeps installation costs to a minimum on the all-steel welded extractor. The separator can be installed on the existing stack of any wet gas scrubber. The manufacturer recommends that approximately six ft of the existing stack be utilized as longer sections may make the unit difficult to install and to maintain. The stack can be extended 10 ft above the moisture extractor if a greater total stack height is necessary.

THERMOCOUPLE

△ Leeds and Northrup Co.'s new expendable immersion thermocouple for molten steel temperatures is a one-shot item and is said to be comparable in cost with present methods.

The new equipment consists of a length of standard one-in. black iron pipe with a handle on one end and a fitting on the other to hold the cartridge. The cartridge, and a 4-ft paper sleeve protecting the

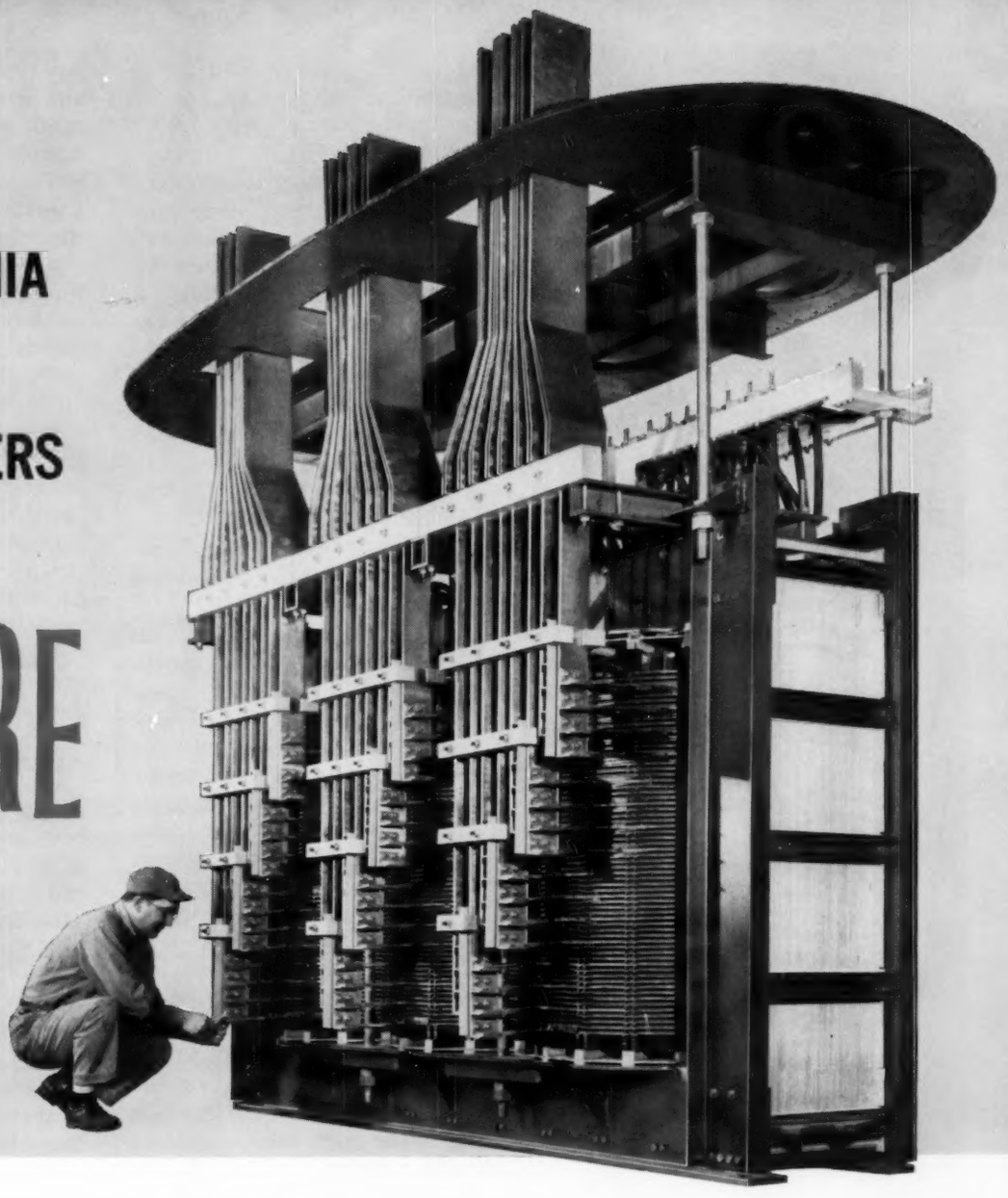


immersed length of pipe, are the only expendable items. Both are easily pulled off and replaced for each reading.

The cartridge itself is a refractory cylinder with contacts at the receptacle end and a platinum, platinum-10 per cent rhodium thermocouple enclosed in a U-shaped sheath extending from the immersion end.

The couple's entire immersion end is enclosed by a hemispherical sheet-steel cap, which melts away in the molten steel to expose the couple. The cartridge is easily plugged into place at the end of the

How PENNSYLVANIA FURNACE TRANSFORMERS take the TORTURE of Year-in, Year-out Service



Furnace transformers are subjected to repeated short circuits and heavy overloads in ordinary service. Distribution of currents and reduction of copper eddy losses also must be given special consideration.

Throughout the years, Pennsylvania Transformer has earned an unsurpassed reputation for meeting these challenges—in installations ranging from 250 through 25,000 kva, and from 3175 through 82,000 amperes. Here are some of the reasons.

Balanced, Precompressed Coils

Coils are balanced to reduce axial short-circuit forces to a minimum . . . and the circular shape protects the coils against deformation by radial short-circuit forces. Also, coils are precompressed with a pressure equal to the maximum short-circuit force that might occur in service. As a result, no additional distortion or displacement can take place.

Bracing of Coils, Bus Bars

Coils are firmly braced, top and bottom, by clamping plates attached to structural steel frames. The accompanying photograph also shows the sturdy supports used for low voltage bus bars. Interleaving of bus bars tends to counterbalance the lines of force and prevent distortion during short circuits.

Distribution of Current

Because of the heavy secondary currents, the winding is subdivided into numerous parallel sections. Transposition of the individual conductors of each section reduces copper eddy losses to a minimum. This results in improved efficiency, more uniform copper temperature, and prevention of hot spots.

To take advantage of these and other time-proved features of Pennsylvania Furnace Transformers . . . contact Pennsylvania Transformer Division, McGraw-Edison Company, Box 330, Canonsburg, Pa.

NEW EXTERNALLY-MOUNTED TAP CHANGER

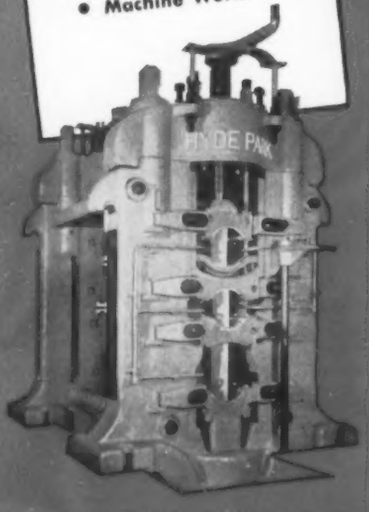
Although a duplicate of a previous order, this 12,000-kva Pennsylvania Furnace Transformer differs from its "twin" in one detail. Its motor-driven tap changer is housed in separate compartments, to facilitate periodic inspection and maintenance. The mechanism includes a provision for emergency hand operation.

PENNSYLVANIA FURNACE TRANSFORMERS

pt

McGRAW EDISON

RED CIRCLE Rolls ALLOY-CHILLED
Hyde Park
Rolling Mill Equipment
For more than 50 years Hyde Park Steel Mill equipment has been helping American industry lead the world — equipment such as—
- Bar Mills
- Merchant Mills
- Sheet and Strip Mills
- Pinion Stands
- Roller Tables
- Reduction Drives
- Stretcher Levellers
- Guillotine Shears
- Sheet Mill Shears
- Roll Lathes
- Special Machinery
- Machine Work



For finer finish, long life and greater tonnage, specify Red Circle Rolls.
Hyde Park
FOUNDRY & MACHINE CO.
Hyde Park, Westmoreland Co., Pa.
ROLLS
ROLLING MILL MACHINERY
GRAY IRON CASTINGS

holder assembly and is designed to assure positive polarized fit.

Here are the advantages of L&N's new equipment:

1. Every reading has new thermocouple accuracy, since each couple is new, properly welded and annealed and uncontaminated by handling. Sealed at the factory, it eliminates the need for contamination checks which are not always dependable.

2. The compact couple assures satisfactory performance for each immersion, because the steel cap protects it from slag and floating solids while entering the bath.

3. High-speed measurements result. A reading can be accomplished within five seconds.

4. The equipment is light and simply constructed and easy to operate. Operator can take a reading without help and can replace the cartridge in seconds. Since the immersion technique for taking readings with the new equipment is slightly different from other methods, L&N has arranged for customer instruction for all new installations.

5. Maintenance is kept to a minimum, as the immersed parts are discarded after each reading. The new couple also ends the need for repair facilities, simplifies purchasing and inventory problems due to the limited number of parts, and eliminates contending with skulls or slag on the assembly.

6. The couple represents a low initial investment. The holder assembly consists mainly of low-cost standard pipe with a few simple fittings at each end. As a result, the equipment is far less costly than previous methods for setting up a new open hearth or electric-arc furnace shop with bath pyrometry.

As the couple gives such high-speed measurements, it requires a faster recorder than conventional ones used till now. However, L&N recorders already in use with other immersion thermocouples can be converted easily with a recorder conversion kit. The company also has designed a new Speedomax G recorder for use with the new couple. It has a two-second full-scale balancing speed, automatic standardization at the time the couple is connected for a reading, and utilizes the familiar green-amber-red signal light system.

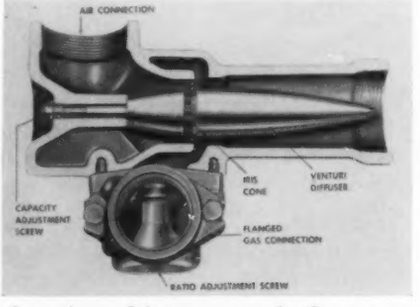
L&N is now offering a kit with all parts nested in numbered sequence and with illustrated instructions to simplify step-by-step assembly of a complete unit. The kit is complete for one measurement and serves as a guide for another kit which omits the iron pipe, the paper sleeve and the cartridge. The latter kit is for those requiring a number of holder assemblies, where the pipe and sleeves will be supplied by the user and where cartridges will be available from separately-ordered stocks.

Finally, the company is offering an introductory package sufficient for 500 readings. Composed of five immersion units, 500 expendable cartridges and replacement parts, the package acquaints shop personnel with the techniques of assembling, handling and servicing the equipment and enables users to evaluate its performance in their own shop.

AIR-GAS MIXER

△ An exclusive design concept has been incorporated into a new line of air-gas proportioning mixers which provides superior adjustability of capacity without need for changing mixer parts for making such adjustments. This is known as the Series AMG "Adjusta-Flow" Mixer, manufactured by Hauck Manufacturing Co.

Optimum "tune-ability" of the mixer to burner nozzles and manifold piping is assured without taking anything apart. Calculating and



changing of jets, venturi, sleeves or rods are eliminated without sacrificing extreme accuracy of air-gas mixing.

The inverted iris cone is expanded or reduced in diameter by means of the external capacity adjustment screw for setting the desired maximum flow rate. Exact mixing pressure is thereby quickly set for correction of various burner nozzle coefficients of discharge and manifold designs.

(*Please turn to page 194*)

THE ENGINEERING MART

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Equipment News

(*Continued from page 192*)

Accurate proportioning of gas and air is secured by the use of a Hauck Zero Gas Governor. Mixture is then made richer or leaner over the entire range by the Ratio Adjustment Screw on the mixer.

Single valve control is obtained for the entire range of mixer operation with a manual- or motor-operated air control valve.

The mixer assures maximum efficiency of performance and convenience of application with the certainty of high capacity rating and wide range of turndown. Adjustments are recessed for full protection.

ALLOYING AGENT

△ Savings of as much as $8 per ton, depending upon practice, can be made in the production of high-manganese stainless steels by using ferromanganese-silicon, a new alloy being produced by Electro Metallurgical Co., division of Union Carbide Corp. The alloy also allows cost savings in making manganese additions to chromium-nickel stainless steels.

Ferromanganese-silicon is used both as a slag reducing agent and a source of low-carbon manganese. The cost of manganese in the alloy is considerably less than any other source of low-carbon manganese currently available. Many melters are using ferromanganese-silicon for slag reduction in place of ferrochrome-silicon, particularly in the production of 200-series stainless steel where substantial cost savings are made in meeting high-manganese specifications.

Melt shop tests show that one pound of silicon in the new alloy reduces oxidized metals in the slag just as effectively as one pound of silicon in ferrochrome-silicon. Although dependent upon slag conditions, high manganese recoveries can be obtained from using ferromanganese-silicon. In many large-scale commercial practices, manganese recoveries have approximated chromium recoveries obtained from a ferrochrome-silicon practice.

Ferromanganese-silicon is specially suited for use where a high manganese to-steel ratio is desired throughout the finishing period of a type 300 stainless steel heat. Many melters believe that the high manganese-to-silicon ratio gives cleaner steel. Savings in costs are obtained in such a practice by using ferromanganese-silicon for straight alloy additions or for partial replacement of ferrochrome-silicon.

The analysis of ferromanganese-silicon is 63 to 66 per cent manganese, 28 to 32 per cent silicon, 0.10 per cent maximum carbon, 0.05 per cent maximum phosphorus, and 0.03 per cent maximum sulphur. It is available in sizes of 75 lb by 2 in., 50 lb by ¼ in., and 3 in. by down.

FLANGE MOUNTED DRIVE

△ Flange mounted gear drives which may be bolted directly to the driven machine are available from the Falk Corp. The unit is designed with bearing capacities for overhung and thrust loads to allow installation of this drive into the driven machine as a geared pillow block, if desired. Thus it is possible to eliminate one machine bearing and cut down the over-all size of the installation.

The drives are built to American Gear Manufacturers Association recommendations and are available for horizontal or for vertical applications, with high speed shaft up or down. These rugged units are furnished from stock in single reduction for applications of ½–10 hp, and in two double reduction ratios for ½–5 hp.

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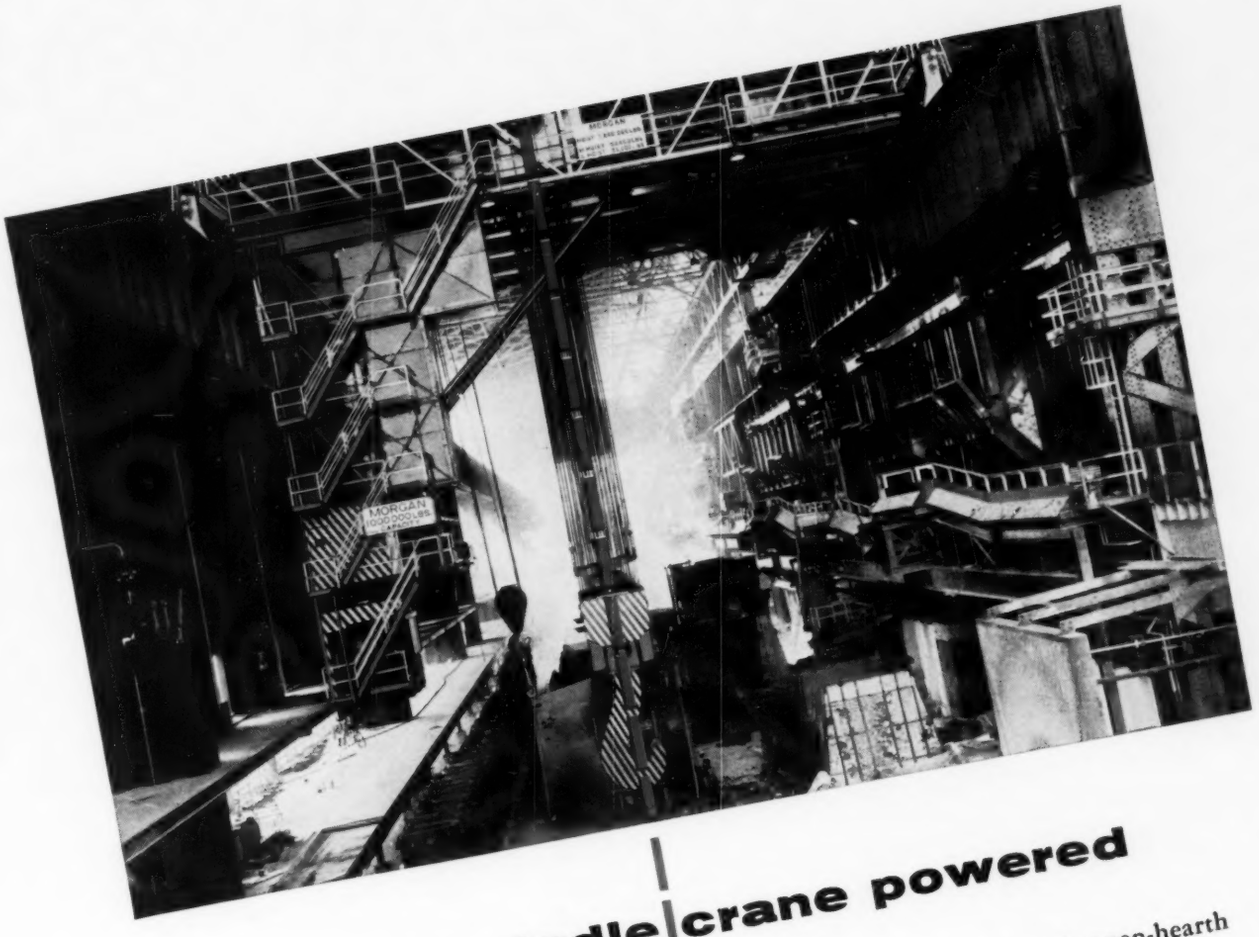

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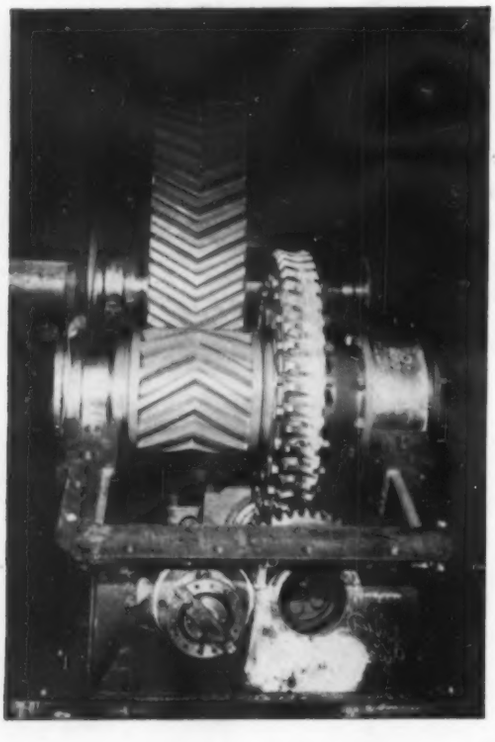

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